CIVIL ENGINEERING

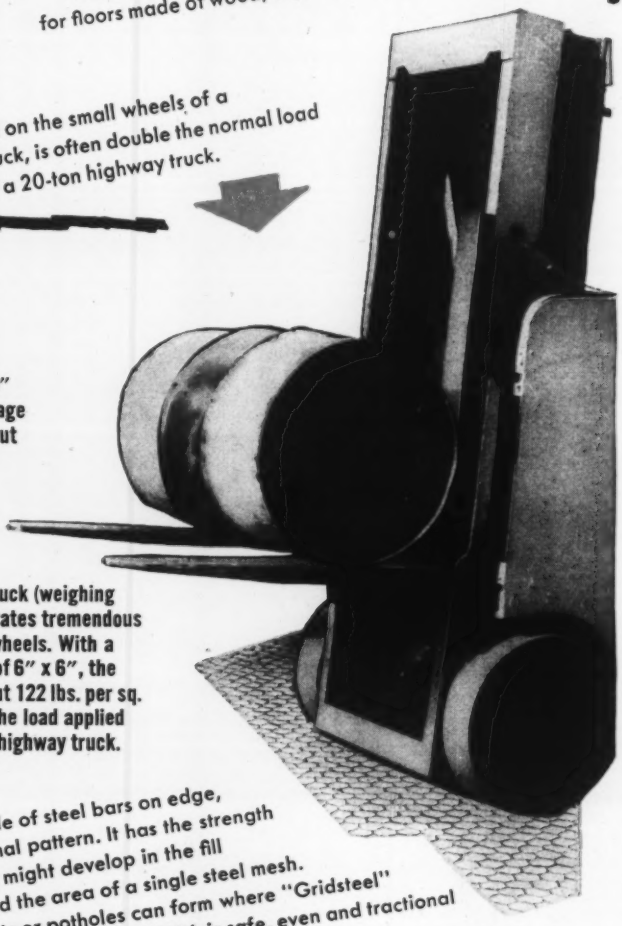
WIND BRACING PRETENSIONED BY HEATING IN QUEEN ELIZABETH HOTEL, MONTREAL. SEE ARTICLE BY DONALD A. CHAMBERLAIN.

TABLE OF CONTENTS – PAGE 3

CAN YOUR FLOOR TAKE TODAY'S HEAVY TRAFFIC ?

The wear from heavily loaded industrial trucks and the impact from heavy objects often prove too severe for floors made of wood, asphalt or even concrete.

The concentrated load on the small wheels of a modern fork lift truck, is often double the normal load applied by the wheels of a 20-ton highway truck.



FOR EXAMPLE:

14" **16000 LBS.** 20"

H-20 TRUCK WHEEL CONTACT AREA

A 20-ton highway truck (with a wheel load of 16,000 lbs. on a 14" x 20" contact area) has an average load concentration of about 57 lbs. per square inch.

6" **4400 LBS.** 6"

LIFT TRUCK WHEEL CONTACT AREA

A 4,000 lb. capacity lift-truck (weighing 6,400 lbs. itself) concentrates tremendous loads on its small steel wheels. With a maximum wheel contact of 6" x 6", the load concentration is about 122 lbs. per sq. inch—more than double the load applied by the wheels of a 20-ton highway truck.

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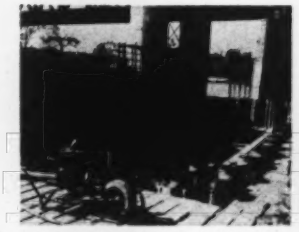
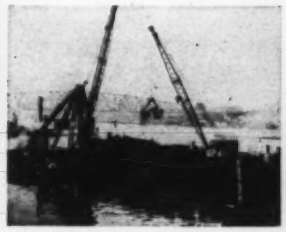
They all used the *"FOSTER PILING RENTAL PLAN"*



Colorado River Bridge Eagle Lake, Tex.
Bob Baker Construction Company



Penn-Lincoln Parkway Pittsburgh, Pa.
John F. Casey Company

Portland Oregon Bridge
Manson Construction & Engineering Co.

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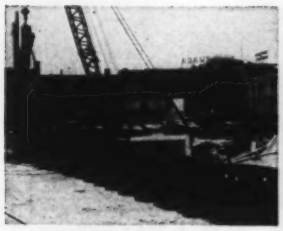

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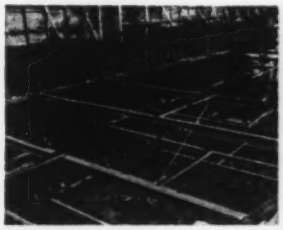

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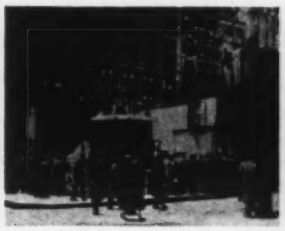
Boh Brothers Construction Co.



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AUGUST 1957
VOL. 27 • NO. 8

THE MAGAZINE OF ENGINEERED CONSTRUCTION

• ARTICLES

M. G. Lockwood 33 **Individual engineers want unity**
Otto Holden, J. L. Soare 34 **Gated structure controls Niagara flow**
P. S. A. Berridge 38 **Prestressing strengthens a wrought-iron bridge**
August L. Ahlf 40 **Thailand's Chao Phya Irrigation Dam**
D. A. Chamberlain 42 **Prestressed wind bracing in Queen Elizabeth Hotel**
R. B. Warren 46 **Can we afford more public construction?**
J. K. Finch 49 **The engineer through the ages—Roman Republic, Part 1**
W. F. Remington 52 **Pretensioned piles for Navy pier**
Edward J. Ramer 54 **Composite welded bridges for N. Y. State Thruway**
Shu-T'ien Li 57 **Unconventional four-level interchange—New Orleans**
C. W. Griffin 62 **Ultimate-strength design of reinforced concrete slabs**

• SOCIETY NEWS

65 **Annual Convention Program in New York highlighted**
66 **Employment restriction withdrawn by BPR**
67 **Tellers canvass ballot for 1958 officers**
68 **Division Doings**
70 **Notes From the Local Sections**
76 **By-Line Washington**

• NEWS BRIEFS

82 **June construction activity sets record for month**
83 **ESA splits over policy**
83 **Two sewage outfalls for Hyperion Treatment Plant**
84 **Experimental prestressed concrete highway is laid**
Robert S. Brandt, Harvey F. Ludwig 88 **Method for photogrammetric map checking**

• DEPARTMENTS

18 News of Engineers
29 Am-Soc Briefs
31 Do You Know That
62 Engineers' Notebook
63 The Readers Write
70 Scheduled ASCE Meetings
90 N. G. Neare's Column
98 Deceased
104 Positions Announced
139 Proceedings Papers Available
114 Men and Jobs Available
115 Recent Books
118 Non-ASCE Meetings
119 Applications for Admission
120 Equipment, Materials and Methods
135 Literature Available
138 From the Manufacturers
144 Index to Advertisers

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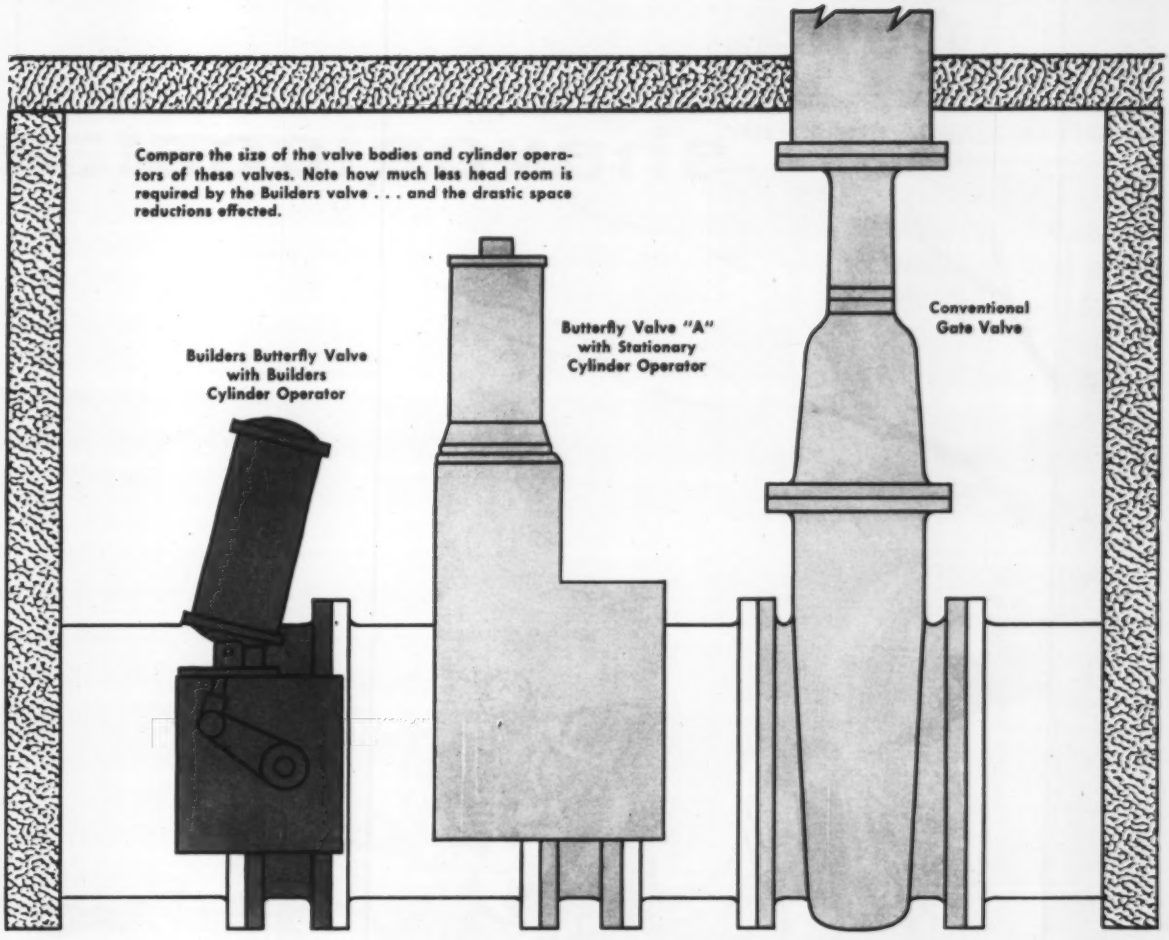
Compare the size of the valve bodies and cylinder operators of these valves. Note how much less head room is required by the Builders valve . . . and the drastic space reductions effected.
Builders Butterfly Valve with Builders Cylinder Operator
Butterfly Valve "A" with Stationary Cylinder Operator
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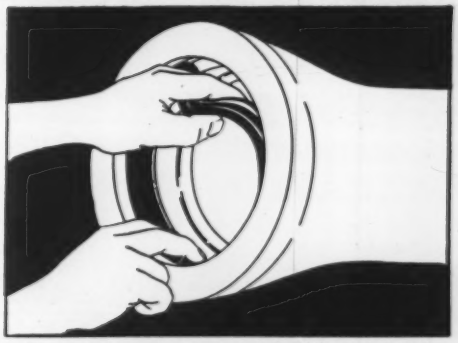
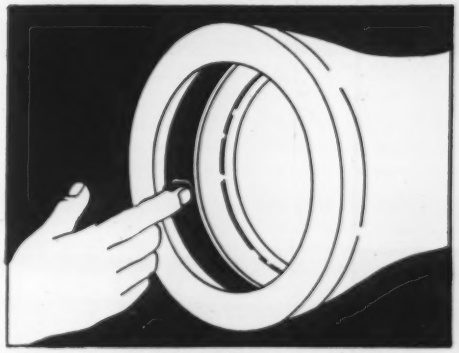
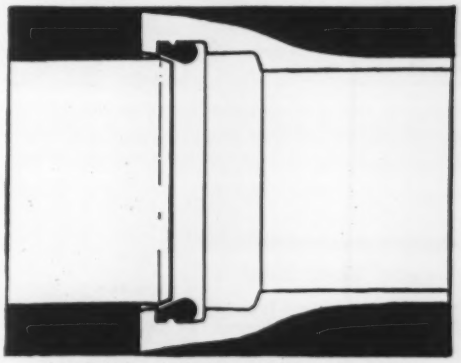


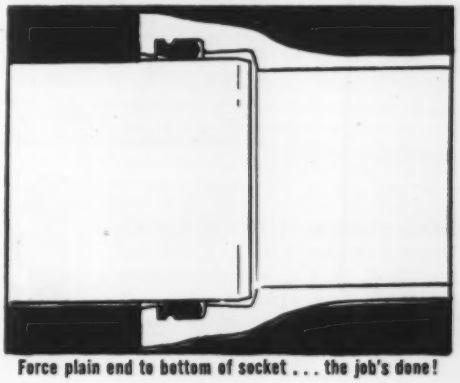
Insert gasket with groove over bead in gasket seat



Wipe a film of special lubricant over inside of gasket



Insert plain end of pipe until it contacts gasket

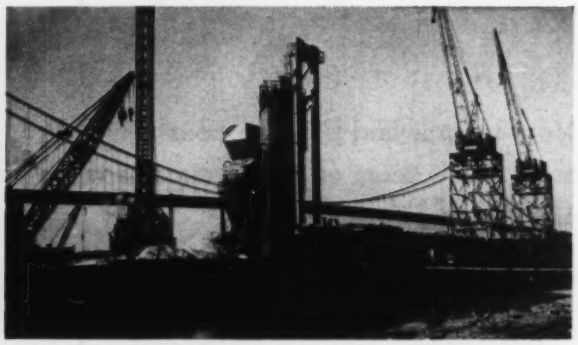


Force plain end to bottom of socket . . . the job's done!

How world's largest underwater concrete placement was made at Camden drydock

Building one of the world's largest drydocks at the New York Shipbuilding Corp., Camden, New Jersey, required the underwater placement of a 134,200-cu. yd. Prepakt concrete floor slab. Here's how this unprecedented placement was made:

First move was direct placement of coarse aggregate from bottom-dump barges inside cellular sheetpile cofferdam. Barges arrived via Delaware River (rear).



Next, Intrusion grout was batched, mixed, pumped from Prepakt plant. I-P methods made possible economical construction of a gravity floor slab, avoiding costly hydrostatic relief of structure.

Underwater consolidation of aggregate was done from rafts. Live grout face was maintained throughout continuous six-week grouting operation.

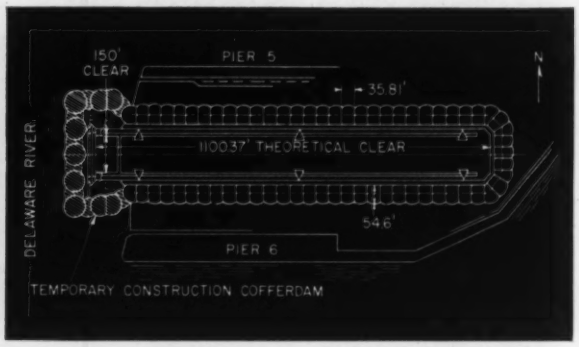


Diagram shows dimensions and location of drydock. Unreinforced Prepakt concrete slab is 17 to 25 feet thick.

Contractor: Merritt-Chapman & Scott Corp.

Consulting Engineers: Parsons, Brinckerhoff, Hall & Macdonald

With grouting completed, slab was cured for 30 days. Dewatering later revealed a monolithic slab—a firm base for new Forrestal-class carriers.

Intrusion-Prepakt, Inc., Room 568, Union Commerce Bldg., Cleveland 14, Ohio. In Canada: Intrusion-Prepakt, Ltd., 159 Bay Street, Toronto, Ontario.

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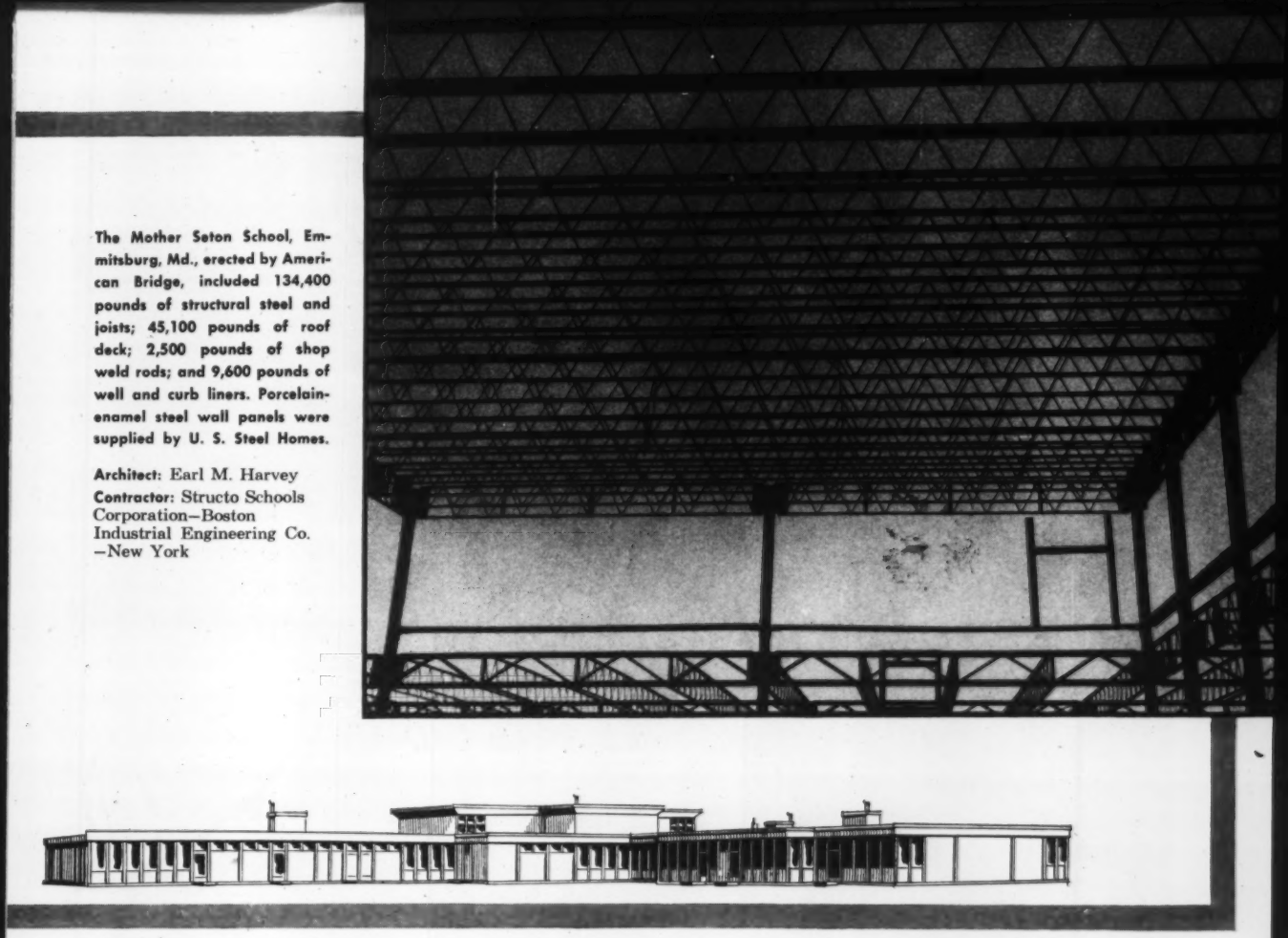

The Mother Seton School, Emmitsburg, Md., erected by American Bridge, included 134,400 pounds of structural steel and joists; 45,100 pounds of roof deck; 2,500 pounds of shop weld rods; and 9,600 pounds of well and curb liners. Porcelain-enamel steel wall panels were supplied by U. S. Steel Homes.

Architect: Earl M. Harvey
Contractor: Structo Schools Corporation—Boston
Industrial Engineering Co.
—New York

Strong, lightweight AMBRIDGE STEEL JOISTS support roof deck of new "Structo"-built Mother Seton School

THE MOTHER SETON SCHOOL of the Daughters of Charity of St. Vincent De Paul in Emmitsburg, Maryland, one of the first "Structo Schools" ever built, combines the use of factory-fabricated porcelainized steel wall panels and AmBridge Steel Joists.

It is significant that this revolutionary type of school construction utilizes AmBridge Steel Joists with framing trusses and square tubular columns to support the steel deck roof.

These joists with square ends and moment connections not only provide strong, rigid, lightweight support for the 57 lb. per square foot roof load, but also offer collateral advantages of continuity for wind loads which make them ideal for use in floor, roof and ceiling construction.

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AmBridge Steel Joists are fabricated and assembled on production lines by American Bridge Division, assuring uniform production, delivered to your job on time.

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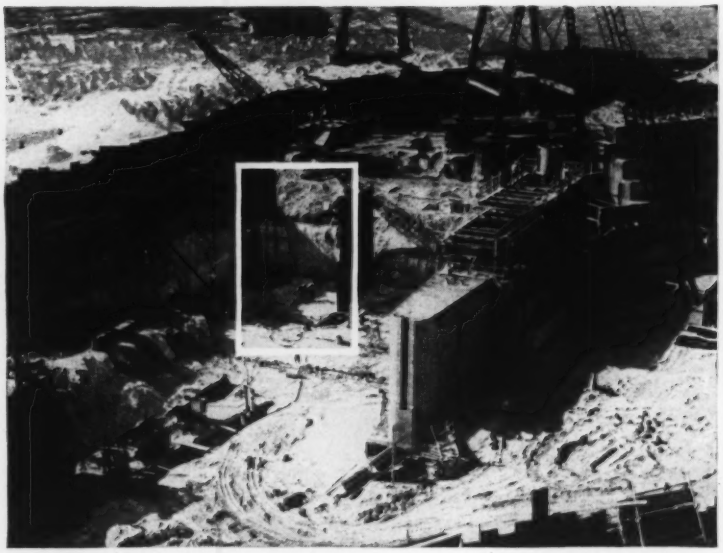

WRITE FOR BULLETIN 100 C

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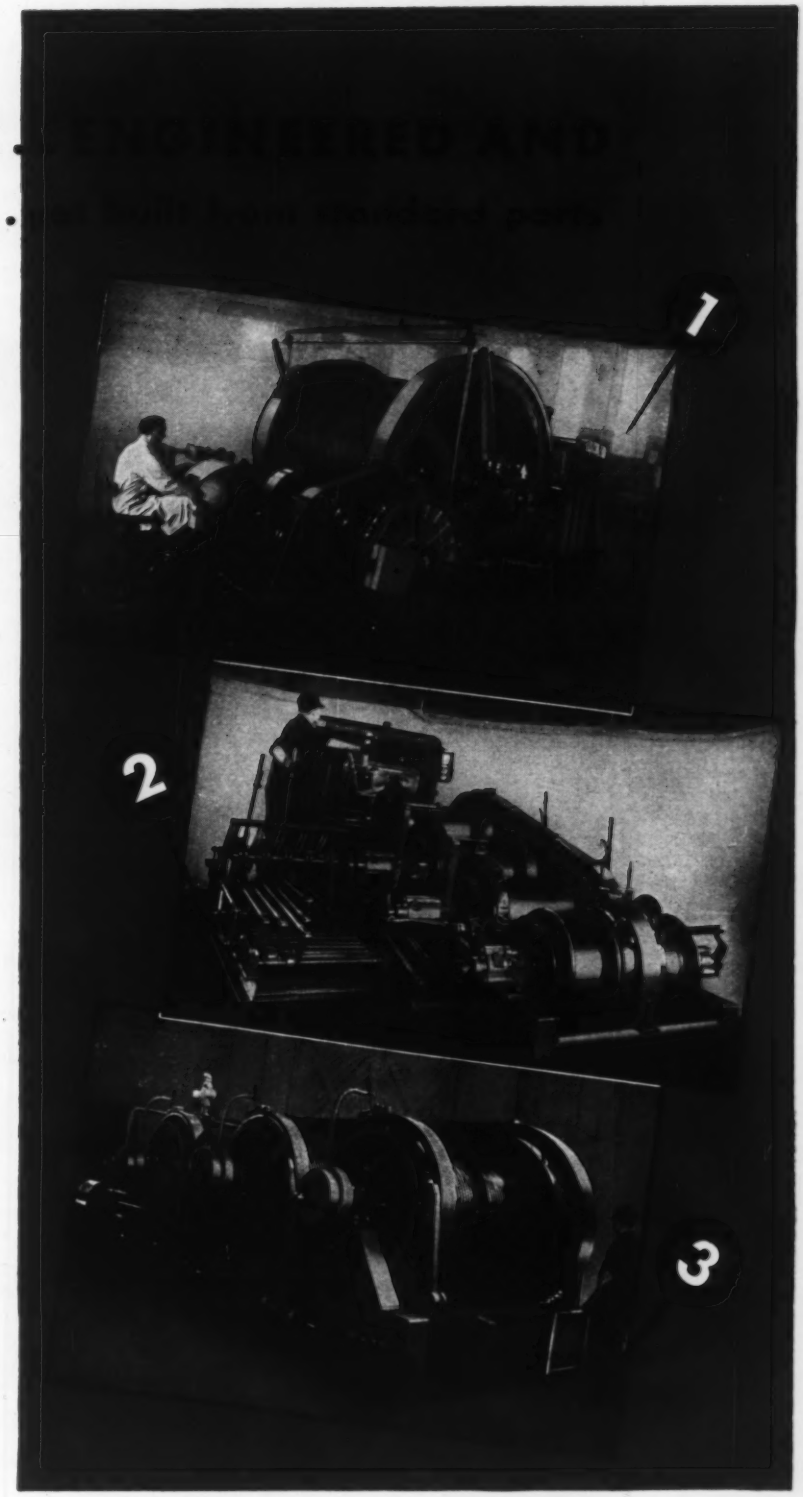

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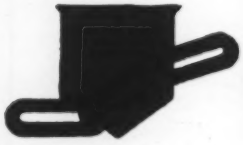

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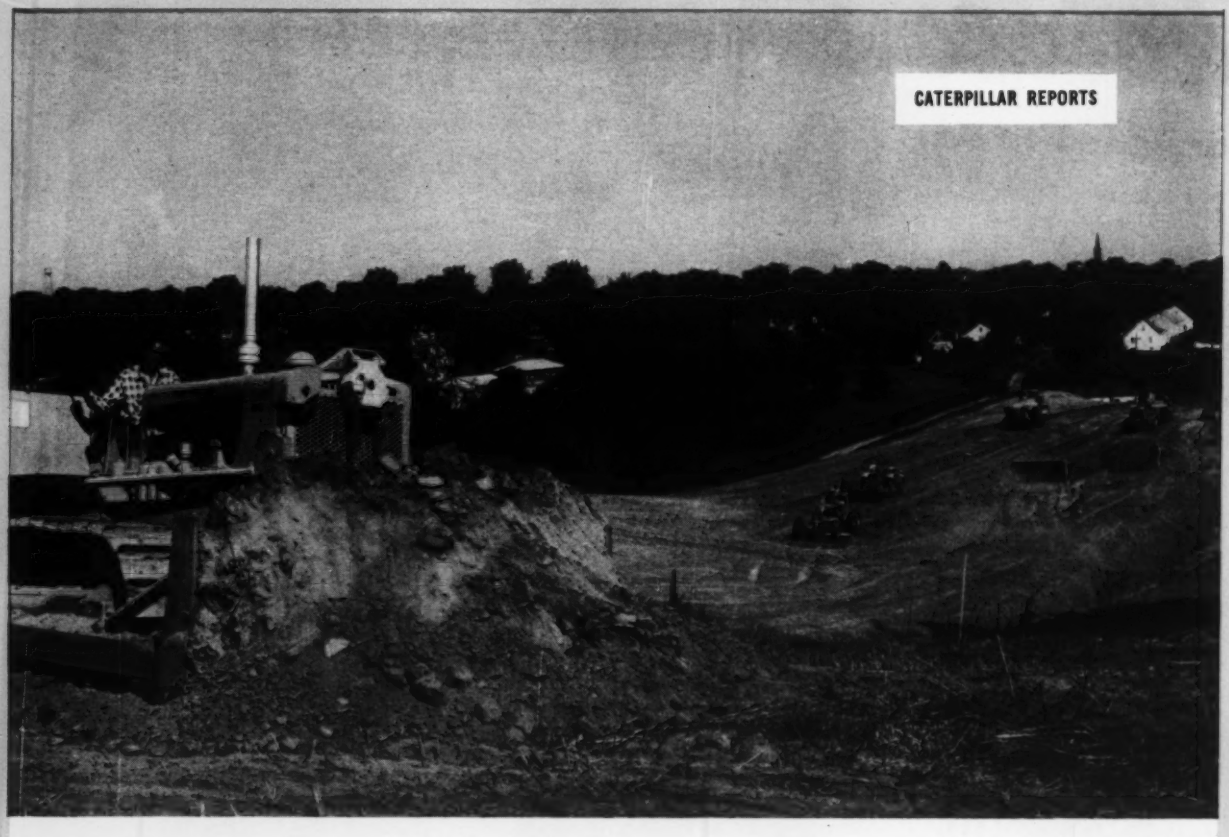

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This is the beginning of the Interstate Highway System—a dream network of wide, safe freeways which will link all 48 states and serve over 90% of all our cities with 50,000 population or more.

The Interstate System is a state responsibility, even though the Federal government is paying 90% of the cost. The states worked out the routes. The states helped decide the standards. Each state will not only purchase the land for its part of the system, but decide what to build first, let contracts and supervise construction.

Missouri was ready to roll when the law was signed last June. Detailed plans were on hand. It had purchased the land for the St. Charles project. And most important, its laws permitted the land to be used for controlled-access roads. Those are roads without intersections. The entire Interstate System will be built that way, a move expected to stop 3500 traffic fatalities a year! And you'll be able to drive across the nation without a stop light.

Sounds good? Then support the plans of your state highway department. For your state may need more money to pay its share of this gigantic program. Or it may need up-to-date laws to acquire land. Your reward will be the largest, most modern highway system in history.

WHAT EVERY CITIZEN SHOULD KNOW ABOUT THE GREATEST CONSTRUCTION JOB

Will the new Interstate System serve your town? When will it be finished? How much is it costing you? You'll be proud of your nation when you get all the facts in the free booklet, "The Road Ahead." Write today to Dept. 2, Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR

REG. U. S. PAT. OFF.

DIESEL ENGINES • TRACTORS • MOTOR GRADERS
EARTHMOVING EQUIPMENT

THE WORLD'S NO. 1
ROAD BUILDING EQUIPMENT

BIG LIFT

for a $50 billion job

One year ago this month a fleet of CAT* machines tore into the earth along Route 40 near St. Charles, Mo.—and the building of this nation's spectacular Interstate Highway System began.

Today, work on this 41,000-mile network of expressways—part of a 50-billion-dollar road program—moves ahead. It's getting a big lift from Caterpillar . . . in two ways that work directly to your advantage:

(1) **Caterpillar national advertising** is supporting this tremendous project in the best way possible: by explaining it to millions of citizens, by pointing out in informative messages exactly what the program encompasses, what it will mean to everyone, ways to keep it moving.

The one roadblock still in the path of our large-scale Federal-aid program is public misunderstanding. An undertaking so immense could bog down unless an interested and enlightened citizenry keeps it on the track. In a new series of full-page four-color advertisements—like the sample on the opposite page—Caterpillar is helping in this important task of public education. For seven years it was Caterpillar advertising which helped mold opinion in favor of the new public roads; today Caterpillar advertising takes on the burden of keeping public opinion informed and alert, in promoting a project in which we are partners, and through which we all will profit.

(2) **Caterpillar equipment** is on the job all over the country, helping build our new expressways efficiently and economically. Caterpillar's intensive program of research and development has given you the most complete line of high-production, cost-cutting earthmoving machines in the world today. There are new and improved models all the way down the line: Tractors, Traxcavators*, Motor Graders, Scrapers and Wagons, Engines and Electric Sets. They're ready *now* to give you greater production, lower operating costs and surer profits in the big job ahead.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR*

*Caterpillar, Cat and Traxcavator are Registered Trademarks of Caterpillar Tractor Co

ONE GOAL: To concentrate our capabilities, resources and experience on the design, manufacture, distribution and service of job-tested heavy equipment.

THE LATEST, MOST COMPLETE INFORMATION ON THE NEW HIGHWAY PROGRAM — FREE

Here is the booklet Caterpillar offers to readers of its national advertising. It contains *all* the latest information on the new highway program: when and where the money will be spent, standards for the new freeways, final routes of the Interstate System. It will be useful in your business — it tells you everything you need to know to share in the greatest construction job in history. Send for your free copies today.

Dept. CE-8, Caterpillar Tractor Co., Peoria, Ill.

Please send me immediately
..... copies of "The Road Ahead."

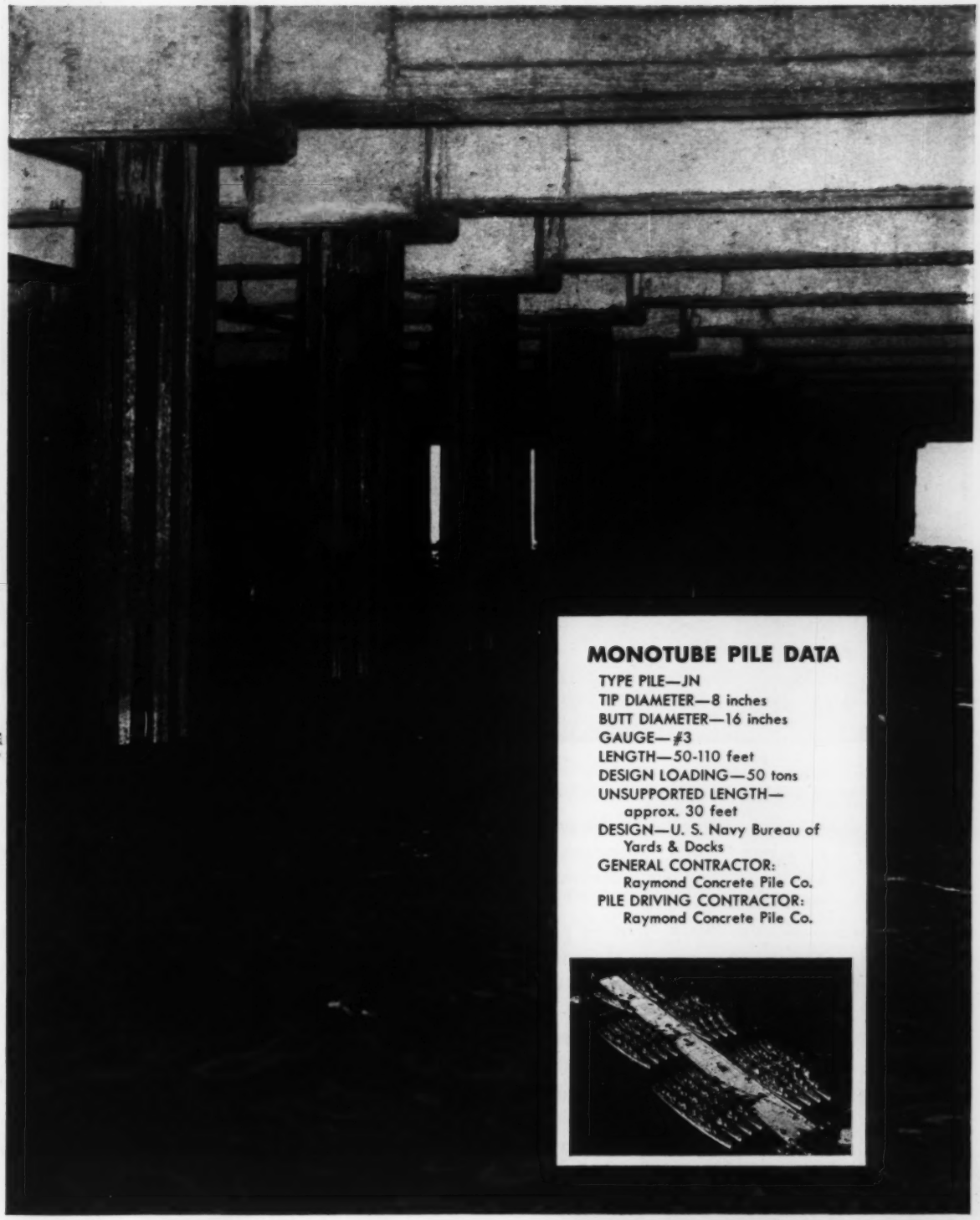
Name.....

Company.....

Address.....

City..... Zone..... State.....

AMDEK
PRESTRESSED PRETENSIONED CONCRETE
BRIDGE SUPERSTRUCTURES
Progress in Concrete
AMDEK reduces bridge building costs through greater ease and speed of handling—eliminates painting and other maintenance. Prestressing, pretensioning and vacuum processing—plus the use of special voids—results in a stronger, lighter combination deck and load-carrying member. This composite beam is rapidly placed in any weather.
Send for new Amdek folder —just off the press.
A-M
AMERICAN-MARIETTA COMPANY
CONCRETE PRODUCTS DIVISION
GENERAL OFFICES:
AMERICAN-MARIETTA BUILDING
101 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS, PHONE: WHITEHALL 4-5600



MONOTUBE PILE DATA

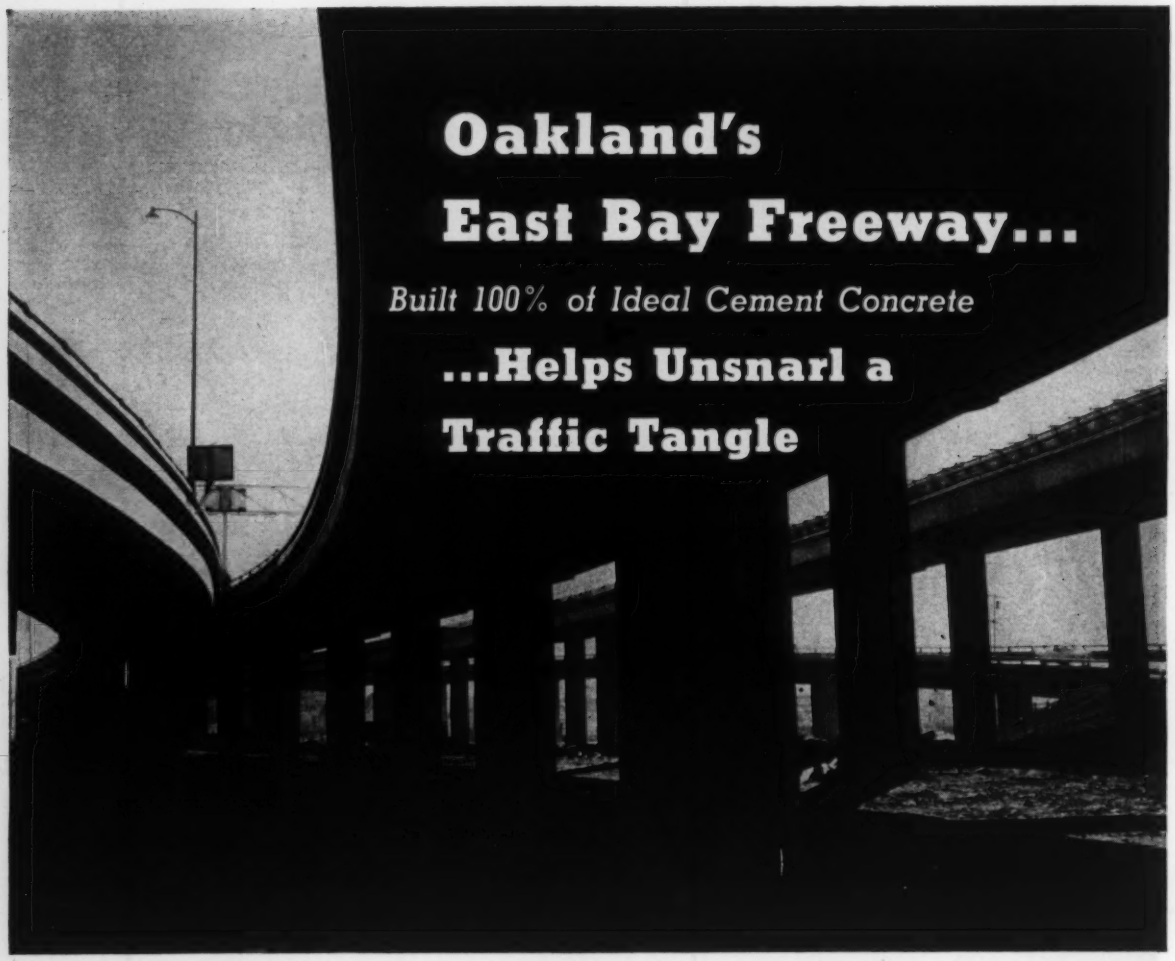
TYPE PILE—JN
TIP DIAMETER—8 inches
BUTT DIAMETER—16 inches
GAUGE—#3
LENGTH—50-110 feet
DESIGN LOADING—50 tons
UNSUPPORTED LENGTH—
approx. 30 feet
DESIGN—U. S. Navy Bureau of
Yards & Docks
GENERAL CONTRACTOR:
Raymond Concrete Pile Co.
PILE DRIVING CONTRACTOR:
Raymond Concrete Pile Co.

STABILITY WITH MONOTUBES . . . ideal as piles with long unsupported lengths in pier work. In the construction of the 1,350-foot U.S. Navy berthing pier, Newport, R. I., piles in excess of 100 feet in length were driven in perfect alignment facilitated by the extreme rigidity of Monotubes.

Tapered, fluted Monotube piles are available in lengths, diameters and gauges to meet every requirement. Write The Union Metal Manufacturing Co., Canton 5, Ohio, for complete information.

UNION METAL

Monotube Foundation Piles



To solve a growing traffic problem at the east end of San Francisco's Bay Bridge, Oakland's East Bay Freeway has been developed.

This multilevel, massive concrete structure is a joint venture of Grove, Shepherd, Wilson, and Kruge, general contractors of Seattle, Washington.

Reinforced concrete was the logical construction material for the East Bay Freeway because of its pleasing appearance, first-cost economy, freedom from maintenance, and ready availability of materials regardless of the rate of use. Portland cement for the job was furnished from Ideal's Redwood City plant, strategically located on deep water directly across San Francisco Bay from the construction site.

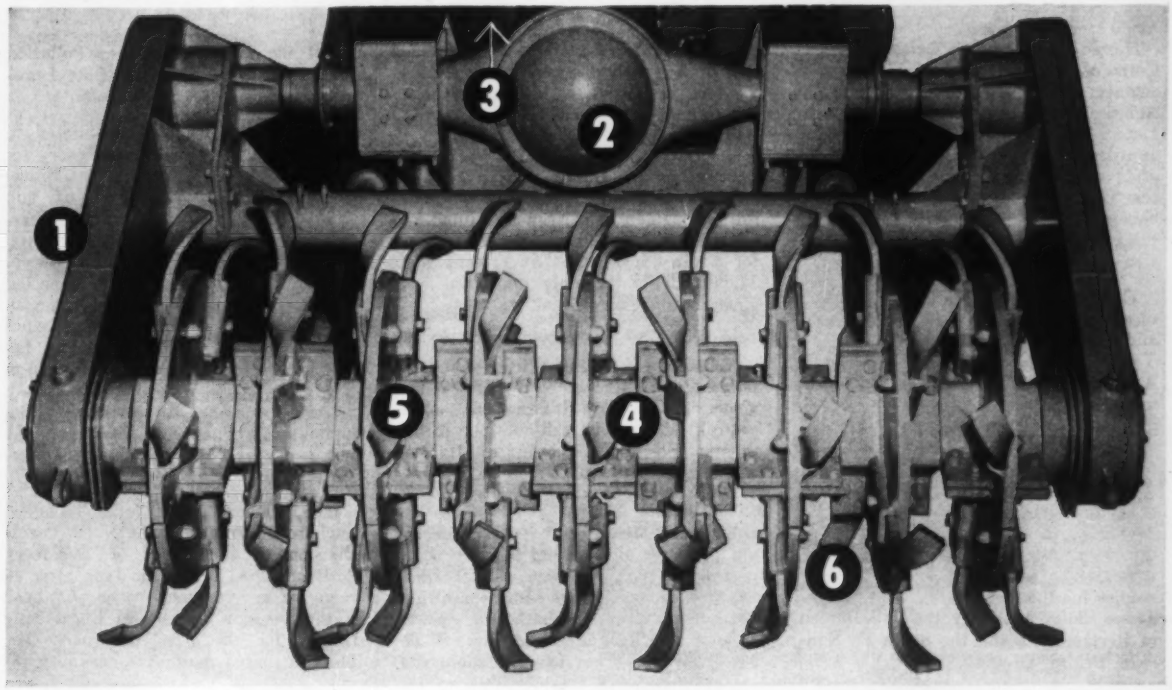
For freeway and elevated highway construction jobs everywhere, reinforced concrete should always receive consideration wherever the elements of beauty, long-range economy, and availability of materials are important.

PORTLAND IDEAL CEMENT

IDEAL CEMENT COMPANY

14 Plants and 2 Cement Terminals Serving the Nation, Coast to Coast and Border to Border

If you are doing Soil Stabilization work, you know why this design is so important



The BROS Roto-Mixer's performance during the past two construction seasons has been sometimes described as truly amazing. If you know in-place soil stabilization machines and jobs, as you review the design features below, you'll readily understand why.

CUTS MIXING TIME

1. Because drives are at outside ends of the rotor shaft, even mixing is accomplished in one pass. No need of a second pass to provide uniform mixing.

Full width mixing or any increment up to 7′ is easily handled. Split-disk type tool plates are quickly removed for shoulder maintenance or other narrow work.

2. Three-speed transmission and 150 usable HP at 1800 RPM provides a greater range of mixing speed . . . and mixing control which eliminates "surging" effect.

3. Independent hydraulic control of rotor and hood provide ample space for proper mixing to 12″ depths. Materials are uniformly blended in a smooth, even course.

CUTS MAINTENANCE COSTS

4. 6″ square solid steel rotor shaft easily withstands shocks and strains of in-place mixing of rocky soils.

5. Split-disk type tool plates are of heavy-duty construction; quickly and easily removed or remounted.

6. Simplified tool holders. Heavy-duty mixing tools are socket mounted, held by one bolt. Replacing worn tools is done in minutes.

You'll be glad to learn of the other important design and construction details of the Roto-Mixer. So see your nearest BROS Distributor for full information and a demonstration. Or write us today.

15TH YEAR BROS

Road Machinery Division

BROS *Incorporated*

(formerly Wm. Bros Boiler & Mfg. Co.)

1057 TENTH AVE. S.E. • MINNEAPOLIS 14, MINN. •

NEWS OF ENGINEERS

Harold E. Bisbort, Colonel, Army Corps of Engineers, and Mobile district engineer, is recipient of the Society of American Military Engineers' highest honor, the Gold Medal Award. The award was presented to him at the society's recent annual meeting in Washington, D. C. Colonel Bisbort was cited for "his work in promoting society objectives in Mobile," including the formation of several local posts.

Constant Robert Marks III, former vice-president, chief designing engineer, and head of the Texas office of the Ambursen Engineering Corp., Houston, has joined the consulting engineering firm of Lockwood, Andrews and Newnam, of Houston. Mr. Marks has been director of engineering designs and studies for the Tennessee Valley Authority, the U. S. Bureau of Reclamation, and the Santa Fe Railroad Bridge Division.

C. R. Marks III

Robert L. Morris announces the formation of a civil and consulting engineering firm in Baltimore, Md. Mr. Morris was formerly senior city planner for the Baltimore Department of Planning.

Gilbert H. Mandeville, Seattle consulting engineer, has been appointed to the Seattle City Planning Commission for a three-year term. At present Mr. Mandeville is the only appointed engineer on the Commission.

Kenneth E. Sorensen has been appointed vice-president of the Harza Engineering Company International, Chicago. In addition he will continue in his present position as head of Harza's Planning Department.

E. Bruce Meier, until recently associate professor of civil and sanitary engineering at the University of Nebraska, has joined the engineering consulting firm of Kirkham, Michael and Associates, of Omaha and Rapid City, S. D. Mr. Meier was a key figure in the drafting of the Nebraska Stream Pollution Act recently passed by the State Legislature.

A. S. Marvin has been promoted to chief engineer for the American Bridge Division of the United States Steel Corporation, Pittsburgh. Mr. Marvin has been connected with the American Bridge Division since 1924, when he became a draftsman in the Gary, Ind., plant. He has been division engineer at Pittsburgh and, for the past two years, assistant chief engineer-contracts.

A. S. Marvin

B. P. Thomas, chief of the Technical Engineering Branch of the North Pacific Division of the Corps of Engineers, Portland, Ore., retired in June after 16 years in government service. As head of the Division's Technical Engineering Branch for the past six years, Mr. Thomas shared major responsibility for

Depend On POSEY For Large O.D. Fabricated Steel Pipe

Posey has the experience as well as the facilities for fabricating almost any type of pipe from 20" diameter and larger . . . for high pressure, high temperature service in water lines, for sewage outfall lines and similar applications. Trust Posey to meet your most rigid specifications . . . with special attention to budget and delivery requirements. Write for complete information without obligation.

POSEY IRON WORKS, INC.
Steel Plate Division Lancaster, Penna.
New York Office: Graybar Building

TANKS • PRESSURE VESSELS • STACKS

CARBON STEEL • STAINLESS STEEL • WROUGHT IRON
STAINLESS CLAD • MONEL CLAD • NICKEL CLAD

the design of such projects as The Dalles, Ice Harbor, Hills Creek, and Cougar dams. Before his assignment to the Division office of the Corps, Mr. Thomas was head of the Design and Planning Branches of the Seattle District. He will establish his own consulting engineering practice in Seattle.

A. M. Westenhoff, retired engineer of construction for the New York Central Railroad, has become an associate partner in the firm of Plumb, Tuckett and Pikarsky, consulting engineers and architects, of Gary, Ind., and Chicago. Mr. Westenhoff was with the New York Central for 39 years, for many years in charge of design and construction of all new structures. His headquarters will be in the Chicago office of the firm.

Ernest L. Eustis, Jr., Commander, Navy Civil Engineer Corps, and for the past three years assistant district public works officer of the Eighth Naval District, New Orleans, has been reassigned to Yokosuka, Japan, where he will be assistant officer in charge of construction, Bureau of Yards and Docks contracts for the Far East.

Earle B. Butler, Lieutenant Colonel, Army Corps of Engineers, graduated in June from the Industrial College of the Armed Forces at Fort Lesley J. McNair, Washington, D. C.

Charles A. Chaney, consultant in the field of marina construction, announces the merger of his firm, C. A. Chaney & Associates, Chevy Chase, Md., with Frederic R. Harris, Inc. of New York. The new organization, with headquarters in New York City, Washington, Philadelphia, New Orleans, and Caracas, Venezuela, will specialize in the planning and construction of marinas.

John F. Michel, former Lieutenant Colonel, Corps of Engineers, has been appointed to the civil engineering staff of Rader and Associates, engineers and architects of Miami, Fla. For several years Colonel Michel was in France with the Joint Construction Agency under the Department of the Army, building airfields and other military installations.

W. R. Holway and Associates, consulting engineers, of Tulsa, Okla., have moved their offices from 302 East 18 Street to 1850 South Boulder.

Emil A. Verpillot has retired as deputy chief engineer of the New York City Department of Marine and Aviation, after 36 years of service to the city. His projects included the design and construction of the $23 million ferry, bus and railroad terminal at St. George, S. I., and Pier 57, the Hudson River terminal of the Grace Line. Mr. Verpillot will now be connected with Wigton-Abbott, engineers and builders of Plainfield and Newark, N. J.

Herbert C. Clare, sanitary engineer in charge of the Pacific Northwest office of the U. S. Public Health Service, was elected chairman of the Columbia Basin Inter-Agency Committee at its recent 92nd meeting. Mr. Clare succeeds **Brig. Gen. L. H. Foote,** division engineer for the Corps of Engineers at Portland.

Robert S. Calkins has been transferred from Upper Darby, Pa., to Lincoln, Nebr., by the U.S. Soil Conservation Service. He will be materials engineer in the Soil Mechanics Laboratory at Lincoln. Mr. Calkins was a design engineer in the Services Engineering and Watershed Planning Unit at Upper Darby.

John S. McNown has resigned as professor of engineering mechanics at the University of Michigan to become dean of the School of Engineering and Architecture and professor of applied mechanics at the University of Kansas at Lawrence. Dr. McNown has been hydraulic research consultant to the Bureau of Public Roads since 1949. He is holder of the Society's J. C. Stevens Award and Research Program Prize, and is currently vice-chairman of the executive committee of the Engineering Mechanics Division.

John S. McNown

Fernando J. Tomassoni has joined the staff of Rader and Associates, engineers and architects of Miami, Fla. A former research and project engineer at the Waterways Experiment Station, Vicksburg, Miss., Mr. Tomassoni recently returned from Thailand, where he was soils engineer in charge of the materials laboratory during road-building work in that country.

Franklin K. Van Zandt has recently been transferred from the Topographic Division of the U.S. Geological Survey, Washington, D. C., to the Bureau of Land Management, Department of the Interior. Mr. Van Zandt now occupies a newly established position initiated to increase use of photogrammetric methods in cadastral surveys.

F. Alan Tiarks has been promoted from Cofar product manager to general sales manager of the Granco Steel Products Company of St. Louis, Mo. Mr. Tiarks has been in the Company's engineering department since 1950.

(Continued on page 20)

Waterstop
in place
in seconds!

LABYRINTH WATERSTOP after first pour has been made and form removed. The grooves receive the concrete from the second pour, providing an interlocking joint.

Just a few seconds were needed to nail this LABYRINTH WATERSTOP to the form... just a few seconds and water seepage worries were over before they could ever have a chance to start. LABYRINTH WATERSTOP forms a waterproof bond between two pours. The corrugated ribs bond firmly with the concrete.

LABYRINTH WATERSTOPS are made of flexible polyvinyl plastic... that has superior weathering qualities, is not affected by temperature changes and chemical activity.

LABYRINTH WATERSTOPS are easy to work with, can be cut to any desired length. "L" and "T" joints can be welded with just a hot knife. Find out now how your costs can be cut... and end your seepage problems. Just mail the coupon to:

WATER SEALS, *inc.*
9 SOUTH CLINTON STREET
CHICAGO 6, ILLINOIS

Made in Canada for
J. E. Goodman Sales Ltd.
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9 South Clinton Street
Chicago 6, Illinois

Send full information and sample

Name_____

Company_____

Address_____

City_____ Zone___ State____

News of Engineers

(Continued from page 19)

C. H. Ferguson, northwest regional engineer for Intrusion-Prepakt, Inc., Seattle, has been appointed manager of the San Francisco regional office. Mr. Ferguson has been connected with Intrusion-Prepakt since 1952.

W. L. Malony, consulting engineer of Spokane, Wash., announces the formation of W. L. Malony and Associates for the practice of professional engineering. Associates in the firm are **J. Byron Barber** and **Arthur J. Dunn.** Mr. Malony is a former Director of the Society.

Recent staff changes at the Keystone Portland Cement Company, New York City, include the appointment of **Edwin K. Borchard,** who has been connected with the company for 22 years, as technical consultant, and of **John F. Hall,** former project engineer for the Pavlo Engineering Company, New York City, as manager of the technical department.

Two recent changes in the California Department of Water Resources at Sacramento involve ASCE members. **Donald P. Thayer,** serving the department since 1952 as principal engineer in charge of the dam design section, has been appointed assistant division engineer in charge of the Design Branch, Division of Design and Construction. **Theodore Neuman,** formerly in charge of the Design Branch, has been made assistant division engineer in charge of the Projects Administration Branch. Mr. Neuman has been with the Department of Water Resources and its predecessor agencies since 1924.

Leroy C. Smith, past-president of the Michigan Section of the Society, has retired as Wayne County highway engineer, Detroit, Mich. Mr. Smith held the post since its inception in 1919. Succeeding him is **Joseph W. Gross,** former executive engineer, who has been connected with the Wayne County Road Commission for the past 28 years.

Joseph Gross

Leroy Smith

E. Russell Johnston, Jr., since 1949 assistant professor of civil engineering at Lehigh University, has been appointed professor of civil engineering at Worcester Polytechnic Institute. During his stay at Lehigh Mr. Johnston directed collective protection projects for the university's Institute of Research.

Jacque S. Minnotte, chief of the Construction Division of the Pittsburgh Engineer District of the Corps of Engineers, has received the Wheeler Medal of the Society of American Military Engineers for "reorganization of the Construction Division and training of the expanded work force for military construction in the District." The medal is awarded each year for outstanding contributions to military engineering.

Recent additions to the Highways Division staff of the Automotive Safety Foundation include **Robert N. Grunow,** since 1949 program and planning engineer for Division 3 of the U. S. Bureau of Public Roads, and **Reed H. Winslow,** who has been studying for his M.E. degree at the Institute of Transportation and Traffic Engineering at the University of California.

William H. Sorrell and **James D. Mattis** have formed a new consulting engineering firm under the name of Sorrell & Mattis Associates, Inc. The firm's offices will be at 1637 North Illinois Street, Indianapolis, Ind.

Charles S. Bergman has joined the consulting engineering firm of Morton S. Fine, Hartford, Conn. For the past eleven years, Mr. Bergman has been associated with Levitt & Sons, Inc., Levittown, Pa., as an engineer engaged in the planning of suburban communities in Long Island, Pennsylvania and New Jersey.

Vincent J. Johnkoski, administrative assistant to the State Road Commissioner of West Virginia, and **Joseph S. Jones,** assistant chief engineer of the West Virginia Public Service Commission, have accepted positions with Michael Baker, Jr. Engineers Inc. Mr. Johnkoski will be project engineer, and Mr. Jones bridge engineer. Both will be in the company's Charlestown, W. Va., office.

Willard J. Turnbull, chief of the Soils Division of the Waterways Experiment Station, Vicksburg, Miss., received the honorary degree of doctor of engineering from the University of Nebraska at its commencement exercises this June. An alumnus of the university, Mr. Turnbull received the degree in recognition of his "outstanding professional achievement and distinguished record of unselfish service."

Aubrey M. Tinder, Jr., until recently asphalt paving engineer for the Virginia Department of Highways, at Richmond,

NEXT TIME . . . GET AN

ALSTER AERIAL SURVEY!

Advance planning through an Alster Aerial Survey keeps your project on track — not bogged down like eskimos lost in the desert. Aerial mapping — usually 5 times faster than ordinary methods — cuts survey costs up to 75%, gets construction moving fast.

Send today for FREE BROCHURE!

ALSTER & ASSOCIATES, INC.
AERIAL SURVEYS

DEPT. C-27, 6135 KANSAS AVE., N. E., WASHINGTON 11, D. C.

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TIDE GATES

Figure B-175. Type M-R Gates designed especially for application to centrifugal pump discharge lines. A rubber seating ring is inserted in the seat to absorb the slap which occurs when pumps stop. A flexible bar connection is arranged between the hinge links to provide a stop for the gate shutter to prevent the outer edge of the shutter from tipping downwardly when flow abruptly ceases. Smaller sizes of gate are provided with a bumper arrangement to prevent the shutter being forced too widely open when flow starts.

Ask for Bulletin 73A

BROWN & BROWN, INC.
LIMA, OHIO, U. S. A.

Diamond Core

Drilling

CORE BORINGS

for

Foundations, Dams,

Bridges and all

Heavy Structures

GROUT HOLES

Tinney Drilling Co.
Grafton, W. Va.

has been appointed district engineer for the Asphalt Institute, Atlanta, Ga. Mr. Tinder succeeds **Frank H. Gardner,** who has been transfered to the Asphalt Institute's headquarters at College Park, Md.

Four ASCE members were honored by the American Society for Testing Materials at its sixtieth annual meeting held in Atlantic City this June. **Stanton Walker,** director of engineering, National Sand and Gravel Association, Washington, D. C., was recipient of the second Frank E. Richart award for "notable contributions in the field of concrete and concrete aggregates." **Albert G. H. Dietz,** professor of building engineering and construction at M.I.T., was cited for "constructive leadership in the work of Committee C-19 on Structural Sandwich Constructions"; **Theodore Parker Dresser, Jr.,** chief engineer and vice-president, of Abbot A. Hanks, Inc., San Francisco, was cited for ". . . valued service in advancing the interests of ASTM on the West Coast"; and **Walter Charles Voss,** professor emeritus and lecturer, department of building engineering and construction at M.I.T., was honored for his "long-time support of ASTM research and standards work, including both administrative and technical aspects."

Fred L. Plummer has resigned as director of engineering of the Hammond Iron Works, Warren, Pa., to accept appointment as national executive secretary and technical director of the American Welding Society, with headquarters in the Engineering Societies Building, New York.

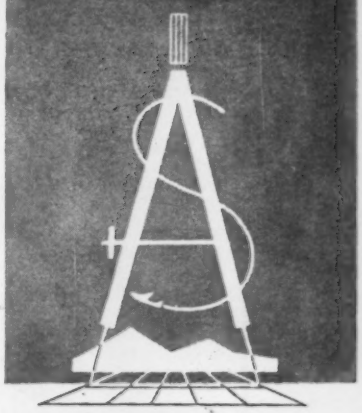
F. L. Plummor

Niels K. Steenhill, for the past five years general superintendent of construction for the Rust Engineering Company, Pittsburgh, has been appointed project manager of the company. Mr. Steenhill became connected with the Rust Engineering Company in 1940 as a field engineer.

John T. Percy has resigned as associate professor of civil engineering at Rensselaer Polytechnic Institute after eleven years on the staff to become a partner in the engineering firm of Hill & Percy, Dalton, Mass. The firm will specialize in mechanical and structural engineering.

Helmer A. Holmstrom, Colonel, Army Corps of Engineers, has been assigned to the post of Corps Engineer, 18th Airborne Corps, Fort Bragg, N. C., considered one of the top posts in the Corps. Since April 1955 he has been in France as commanding officer of the U. S. Army Engineer Depot at Toul.

AIR SURVEY CORPORATION



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Advances starting time.

Conserves engineering manpower.

Produces fast but factual data.

Is economical but exact.

1101 LEE HIGHWAY, ARLINGTON 9, VIRGINIA

TESTERS

For

CYLINDERS

BLOCKS

LINTELS

BEAMS

CUBES

PIPE AND SLABS

If it's a concrete tester you need—get in touch with

FORNEY'S, Inc.
TESTER DIVISION
P. O. BOX 310 · NEW CASTLE, PA.

Architects: Eggers and Higgins; *Structural Engineers:* Weiskopf & Pickworth; *Mechanical Engineers:* Syska & Hennessy, Inc.; *General Contractor:* George A. Fuller Co.

High-strength bolts join framework of new office building in Newark

This handsome 20-story office building with colorful blue-green facade and white limestone trim, nearing completion in Newark, N. J., is the home office building of the Mutual Benefit Life Insurance Company. The structural members making up its 7,000-ton steel framework were bolted together with thousands of Bethlehem High-Strength Bolts.

Bethlehem High-Strength Bolts save time in erecting steelwork because they can be installed quickly, with no more equipment than a holding wrench and a pneumatic impact wrench. And the joints are permanently tight!

High-strength bolting is a particularly desirable type of construction in hospital and school zones, as the pneumatic wrench used in tightening the nuts is far less noisy than a riveting gun. Besides, with the bolts installed cold, there's no fire hazard to worry about. Nor is there danger of injury from the tossing of hot rivets.

Bethlehem High-Strength Bolts are made of carbon steel. They are heat-treated by quenching and tempering, and meet every requirement of ASTM Specification A-325.

Save time by using Bethlehem High-Strength Bolts on your next construction job. The nearest Bethlehem sales office will be glad to supply full information. Or, if you prefer, write to us at Bethlehem, Pa.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

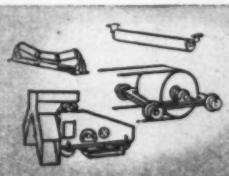
BETHLEHEM STEEL

BETHLEHEM STEEL

WHAT BUT A BELT CONVEYOR could carry this load for so few pennies a ton?
Moving at high speed—24 hours a day if required—belt conveyors handle huge tonnages in a continuous stream. Loading and unloading delays are eliminated, and there's no time lost on empty return runs. Operating costs are relatively low, based on cost per ton handled. In fact, economies of belt conveyor operation and upkeep generally top any other form of bulk material transportation. And thanks to their extreme flexibility, installation is easy even in difficult locations.

WHO BUT LINK-BELT offers such a complete belt conveyor service? For any requirement—new installation or modernization job—Link-Belt will plan it, equip it, erect it and stand behind it. Our engineers can choose from industry's most comprehensive idler line—plus a broad range of pulleys, drives, terminal machinery and auxiliary equipment. Because all drawings and equipment come from one source, responsibility is centralized . . . no need to waste valuable engineering man-hours coordinating drawings from several sources.

OVERALL ENGINEERING



COMPLETE EQUIPMENT

SKILLED ERECTION

ASSURED SATISFACTORY PERFORMANCE

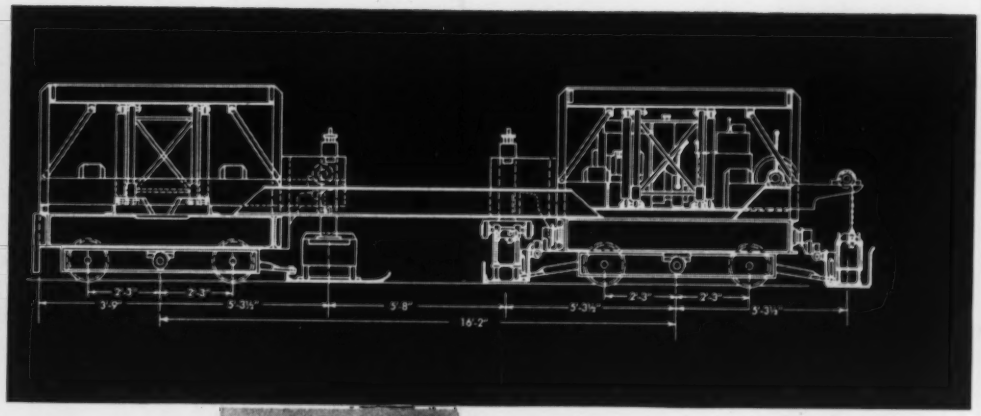
Add to the basic economies of belt conveyors the extra advantages offered by Link-Belt—it's a formula producing lower costs per ton for all industry. Your nearby Link-Belt office can furnish complete information. 14,821

LINK-BELT

BELT CONVEYOR EQUIPMENT

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs.

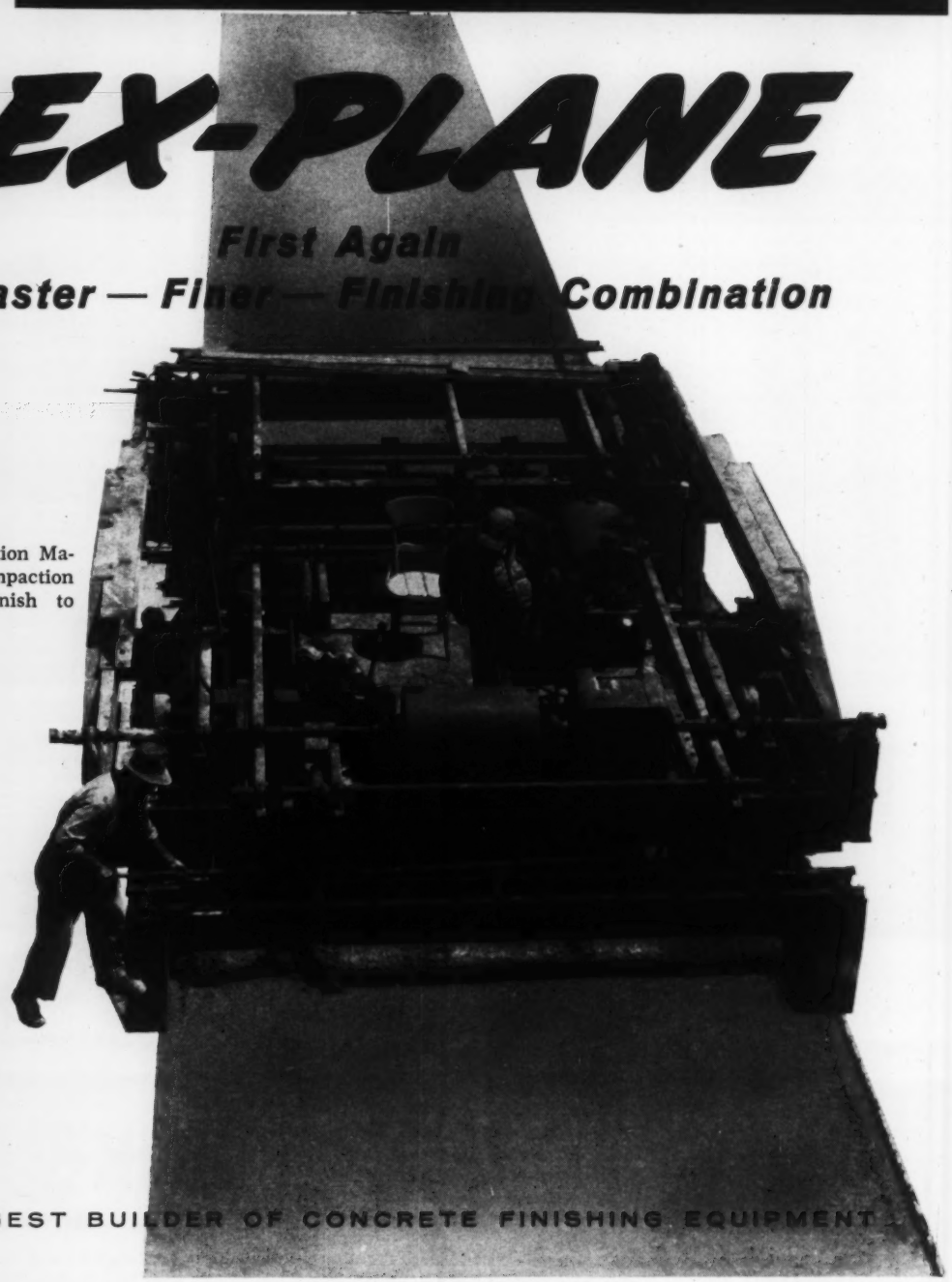
Two Detroit Special finishing machine frames engineered into one rugged unit combining finisher and float operation. Equipped with quick crown change screeds. Supplied in either 12' to 18' or 20' to 25' working widths. Hydraulically controlled pneumatic tired transportation assemblies optional.



FLEX-PLANE

First Again

with Faster — Finer — Finishing Combination



"FLEX-PLANE" Combination Machine gives greater compaction and applies superior finish to Connecticut Turnpike.

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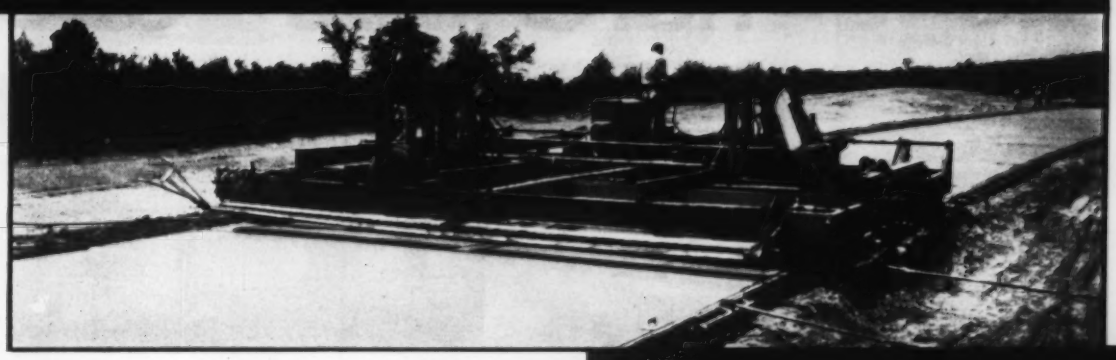
U. S. ROUTE 16—near Farmington, Michigan. Loselle Construction's Combination increases daily finishing average.



". . . 4400 feet of 22-foot pavement finished in one day." . . . "keeps up with three dual drum pavers." . . . "450 lineal feet of 24′ pavement per hour." These are typical reports from contractors using the revolutionary new Flex-Plane Combination Finisher-Float Machine which does the combined jobs of transverse and longitudinal finishers. On the average, users finish over 3000 feet of pavement a day, requiring only two or three hand finishers depending on type of joints being used.

On-the-job checks show longitudinal surface smoothness to be unsurpassed by any other equipment regardless of condition of forms. Results prove it to be the fastest, most efficient finishing machine in use today.

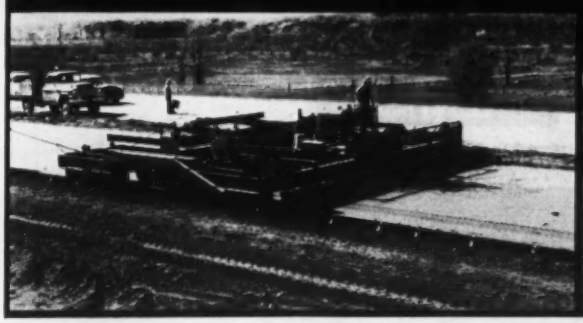
But why not get all the facts? Write today for your copy of the data-packed "Flex-Plane Finisher-Float Machine" brochure. See for yourself why contractors consider it the finest machine of its type in the world.

368

U. S. ROUTE 30 — J. A. Jones Construction Company uses combination on straightaway paving — Flexplane self-widener on interchanges near Mansfield, Ohio.

CONNECTICUT TURNPIKE—DeLillo Construction Company's Combination cuts hand finishing to a minimum.

U. S. ROUTE 12—Kalamazoo, Mich., bypass is worked by Carl Goodwin & Sons. Contractors generally report substantial savings over previous finishing methods.



U. S. ROUTE 23—Combination Machine owned by Denton Construction Company keeps up with three dual drum pavers south of Brighton, Michigan.

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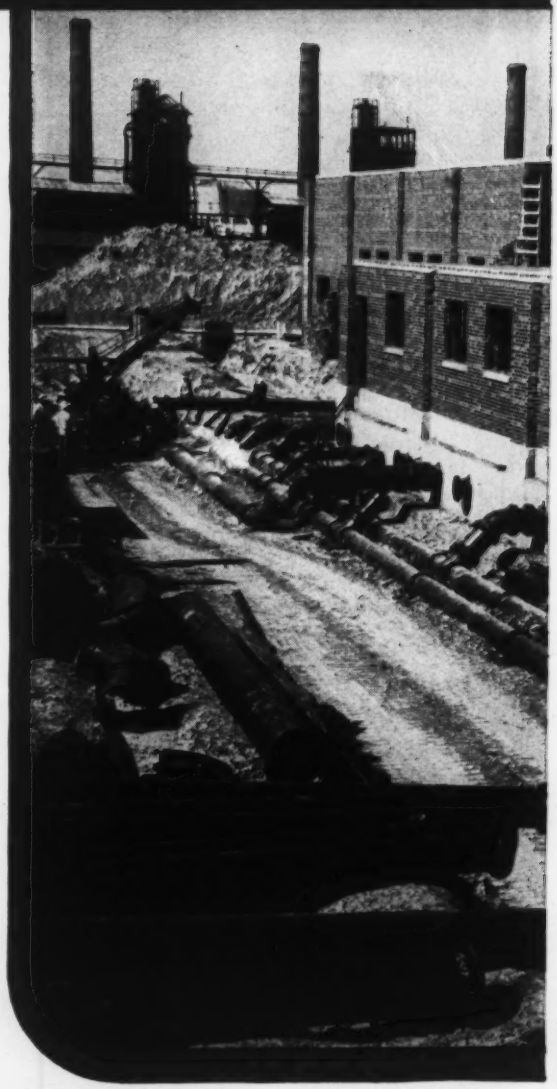

Robinson, Ill.—Mechanical Joint cast iron pipe being installed at Ohio Oil Company Refinery.

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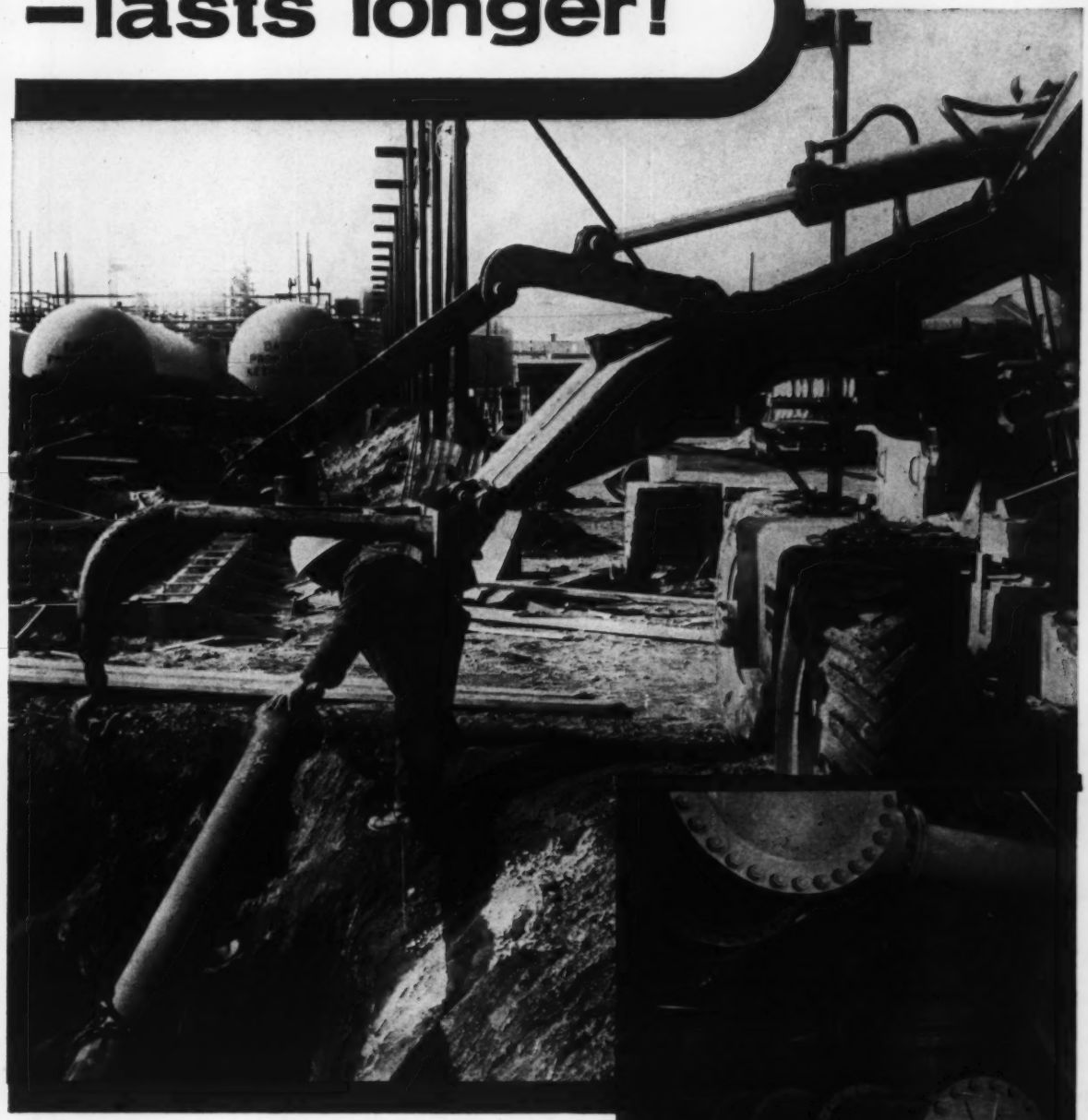

Chicago Heights, Ill.—Cast iron pipe being installed to supply water for plant of Victor Chemical Company.

International Falls, Minn.—Installation of flanged cast iron pipe and fittings in filter plant of Ontario Paper Co.

AVAILABLE NOW! Granco Steel Products Company, leading building-products manufacturer in the Midwest, introduces new deep-beam Guard Rail for highways and bridges—available through distributors in principal cities.

HI-STRENGTH VISUAL BARRIER. Tough carbon steel. Corrugated shape. Acts as a continuous impact-resistant beam. Highways—12-gage; bridges—10-gage. Force of collision is absorbed by posts on *both* sides of the impact. Highly visible, reflects light day and night.

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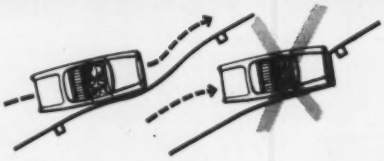

Beam strength and height prevent cars from hurtling over or going under rail. Flared end sections help prevent cars from hitting the end of a rail head on.

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. . . . . Am-Soc Briefs

▶▶ The site for the United Engineering Center has been acquired. It faces UN Headquarters in New York on that part of First Avenue now named United Nations Plaza. Specifically it is 37,500 sq ft of property occupying all frontage between 47th and 48th Streets. Purchase of the site for $2,700,000 by United Engineering Trustees is the first step in plans to meet the needs of 175,000 members of ASCE, AIME, ASME, AIEE, and AIChE for a center for the engineering profession.

▶▶ The Board of Direction has agreed to accept joint sponsorship with the AIA of a World Construction Year set for 1960, and a World Construction Congress slated for Chicago in 1961. The joint program will underscore the importance of construction to the economy of the United States and the world. A resolution recommending the Board's action originated in the Illinois Section.

▶▶ Members attending the Annual Convention in New York this October will find a helpful new feature . . . a commercial exhibit will demonstrate equipment, materials, and methods in engineered construction; advertisers in CIVIL ENGINEERING have taken the 45 booth spaces available. . . . There will be an important Technical Division program, with over 40 sessions scheduled (full Convention program in the September issue). . . . Also an open presentation and discussion of the particularly significant reports of two major committees of the Department of Conditions of Practice: (1) a positive approach to what the Society can do to advance the economic status of its members, and (2) an approach to improving professional education based on the results of a recent survey by Opinion Research Inc. . . . And a new slate of officers will be inducted. . . . Results of the first balloting for officers are reported in the Society News section. . . . Incidentally, don't pass up your chance to vote—the final ballot will be mailed out early in August.

▶▶ The ASCE Group Disability Plan has been broadened again. . . . At no increase in premium there will be a 10 percent increase in payments for loss of time through accident or illness. As requested by many, the Catastrophe Hospital-Nurse-Surgical Plan has been extended so that members may cover their wives and children. . . . For your convenience premiums may now be paid either annually, semi-annually, or quarterly.

▶▶ In line with the concern of members over the national water situation, ASCE has named a special Task Committee on Water Resources, which will work toward increasing the Society's technical activities in the field. Ultimate goal of the committee will be furthering protection of our national water resources. Appropriately, the new task group is headed by W. W. Horner, Past-President of ASCE and former chairman of the EJC National Water Policy Panel.

▶▶ A new milestone—our membership has passed the 40,000 mark and now stands (as of July 9) at 40,073. They reside in 101 countries beside the United States.

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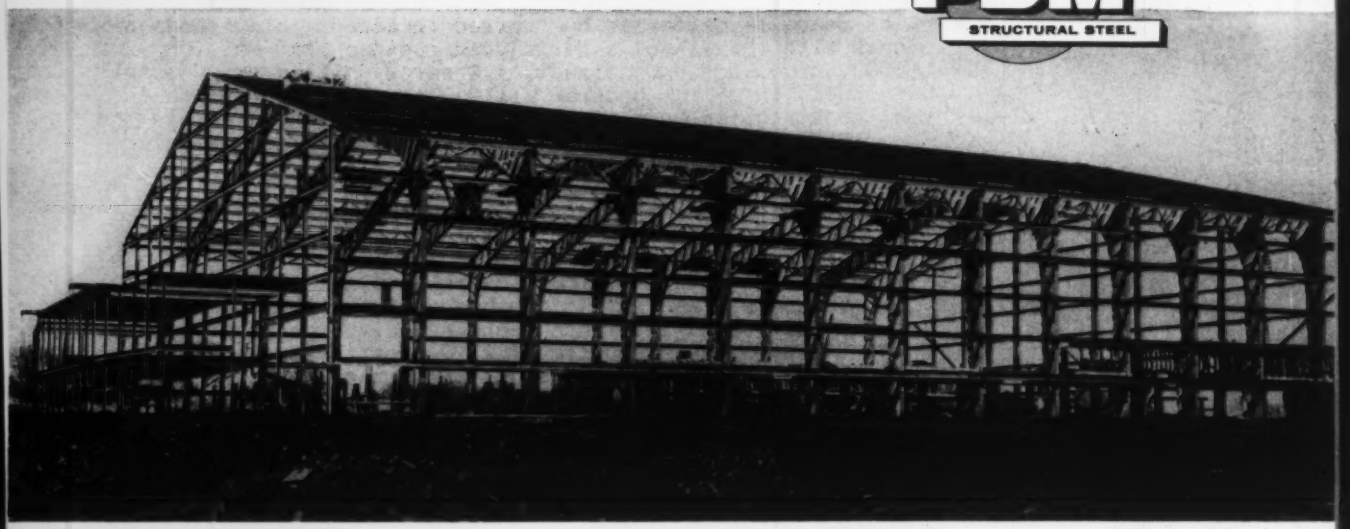
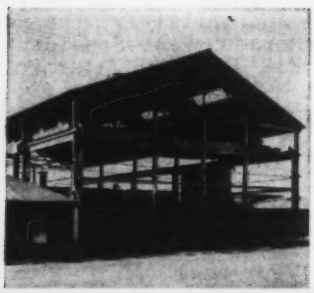


War Memorial Colosseum, Des Moines, Iowa. 2200 tons.

Penn Township High School,
Allegheny County, Pa.



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do you know that

Despite high holiday traffic tolls, the highway accident trend is actually down? This is the encouraging word from the Yale Bureau of Highway Traffic, which reports a decline in the U.S. accident rate from 18 fatalities for every 100,000,000 vehicle miles of travel in 1925 to six for such travel in 1956. In addition to studying the effects of curves, grades, intersections, number of lanes, and the like, the Yale experts are attempting to evaluate the relationship of emotional and social attitudes to accidents.

• • •

Almost half our population are registered drivers? The Bureau of Public Roads reports that there were 77,869,284 licensed motor-vehicle operators in the United States in 1956. Motor vehicle registrations reached 64,437,419. In the seven years since 1949, when such data were first compiled, the number of licensed drivers has risen by 18.5 million, while vehicle registrations are up by 20.3 million. The steady decrease in ratio of licensed drivers to registered vehicles—from 1.34 drivers for each vehicle in 1949 to 1.21 in 1956—is cited as reflecting "a generally higher standard of living."

• • •

The Federal Government is our largest single employer of engineers? In the spot month of August 1954, according to the U.S. Civil Service Commission, there were 60,510 civilians employed in engineering and 70 percent of them were professional engineers. The Army, Navy, Air Corps, and Department of the Interior employed the bulk of these engineers. As is to be expected, the civil engineering field topped the list with more than 20,000 employees. Next was the electrical and electronic field with 9,000 employees.

• • •

The Army is testing a radio-controlled bulldozer? The new robot machine, under study at the Fort Belvoir Research and Development Laboratories, can be operated from as far away as 15 miles. A radio transmitter replaces the operator's seat on the commercial "Tournadozer," made by LeTourneau-Westinghouse. The robot is operated by push buttons on a control box in a jeep or helicopter within a 15-mile range of the radio. Army engineers will try to install a small television camera on the tractor so the distant operator can visually direct its operation. Because of its invulnerability to radioactivity and overhead fire such a unit should be useful for clearing land after enemy attack.

• • •

There is a revival of interest in an English Channel tunnel? The Channel tunnel project, broached periodically since Napoleon's day, is the subject of an intensive current survey of the engineering, geological, financial, and political problems involved. The Universal Suez Canal Company is supplying specialists for the survey. Present plans envisage twin railway tunnels, 17 ft in dia and more than 30 miles long, extending from a point near Dover to Sangatte near Calais. The consensus seems to be that such a long tunnel would not be feasible for automobiles because of the ventilation problem.

• • •

Population density of the Island of Oahu—640 persons per square mile—exceeds that of both Japan and the United Kingdom and equals that of Puerto Rico? The situation is pointed out in a recent report on land use in Hawaii by Harland Bartholomew and Associates. An immediate result of the report, made for the Economic Planning and Coordinating Authority, was the approval in May by Governor Samuel W. King of an act establishing a Territorial Planning Office and appropriating $250,000 to organize and operate it.

• • •

Supplies of uranium are now available for peaceful uses? With the recommendation of the AEC and approval of the President, some 100,000 kg of uranium 235 are now being released for peaceful purposes on a sale or rental basis. Estimated value of this supply is $1.7 billion. Domestic and foreign users will share about equally in the allocations. There will be safeguards to prevent diversion to non-peaceful uses.

• • •

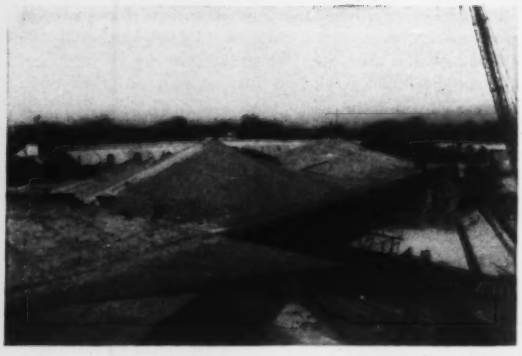
The world's first solar-heated office building survived initial winter trials satisfactorily? At a recent ASME technical session dealing with methods of using the sun's heat for practical purposes, three New Mexico engineers revealed that a solar heating system installed in an Albuquerque office building last year provided adequate heat "through the worst part of the winter including an abnormally cloudy January." The unit consists of an inclined flat-plate collector which uses heat from the sun to warm water. Heat from the water, stored in a 6,000-gal tank, is then used as needed to warm the building. Incidentally, the Corps of Engineers will supervise contruction of a large solar furnace at Cloudcraft, N. Mex., to be operated by the Holloman Air Force Base as a research facility for the Armed Services.

• • •

The economic picture twenty-five years ago was markedly different? Of course you do, but one forgets how vastly different! Engineers returning to the University of Michigan for their quarter-century reunion this June recalled that in 1932 only three out of a class of 275 engineers had jobs at the time of their graduation—at such unprofessional work, for instance, as selling vacuum cleaners for $25 a week. In contrast, representatives of 550 companies haunted the Michigan campus this year and offered 500 graduates jobs with average starting salaries of $469 a month. Some were offered as much as $730 a month.

'Incor' Concrete 'WAFFLE'

Fifty-two Concrete Parabolas Cover 3½-acre Reservoir— Typical 'Incor' Savings



• Kansas City, Kansas, has just roofed its 12-million-gal., 415-ft.-diameter Argentine Reservoir, to prevent algae formation and assure adequate Summer water pressure.

Deriving requisite strength from its shape rather than mass, the hyperbolic paraboloid thin-shell concrete roof design, waffle-like in appearance, cut column requirements by 60%, took only 50% as much concrete as flat-slab construction, saved $21,000 over next lowest alternative design.

Concreted with 'INCOR' 24-HOUR CEMENT, the fifty-two 46 ft. 10 in. square concrete shells, 3 in. minimum thickness, were completed at top economical speed—average, 7 shells in 5 working days.

Shells are supported at their centers, which rise 7 ft. 8 in. above edges, by cast-in-place concrete columns spaced 45 ft. 10 in. each way. Shell edges are dowelled to adjacent shells or to flat-slab perimeter area.

Built in Winter (5° minimum outside temperature), concrete was steam cured, outside surface heat-protected. 'Incor'* produced specified 3200 psi stripping strength in less than 48 hours . . . cut form requirements in half . . . produced maximum job speed at minimum cost.

Net result—quality concrete at less cost—good reason, Winter or Summer, for insisting on America's FIRST high early strength Portland cement.

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Individual engineers want unity

I have yet to encounter an individual engineer anywhere who does not desperately want real unity in the engineering profession. The governing boards of all the national societies are made up of ordinary engineers like you and me—and individually they desire a unified profession just as devoutly as we do.

The trouble is that there is no agreement among individual engineers, hence none among the boards of the national societies, as to how it is to be achieved. A common meeting ground has got to be found soon.

The simple fact is that, at almost all local levels around the country, unity of the engineering profession already is an established and cheering achievement, working effectively to advance the prestige—and hence the social and economic betterment—of all engineers in all branches of the profession. At the national level there is the same deep-seated yearning and spontaneous desire for unity-in-fact. But the innate problems are more complex, more formidable.

To the extent that these problems arise from personal and professional jealousies—and to some extent they do—we can have no sympathy with the situation. But not to recognize it is only to be unrealistic.

In his apportionment of human character, God has played no professional favorites. And despite the engineer's widely recognized and highly commendable capacity for objectivity, many individual engineers possess well ordered sets of immutable prejudices. And when these prejudices have taken their initial set, such engineers do not want anyone to confuse them with the facts.

Administrative staffs of national engineering organizations usually are directed by engineers in the full-time employ of these organizations. These engineers are human too, and are therefore subject to such human foibles as professional jealousy and empire-building ambitions. This, to some degree at least, may have handicapped our national aspirations for more effective unity. If so, the remedy would seem to lie in closer and more frequent communication and personal liaison between elected, non-paid officers and directors of the several organizations.

As will be recalled, the Board of the National Society of Professional Engineers, after long and serious consideration a few years ago, voted to decline the invitation to become a member of Engineers Joint Council. As a member of NSPE, I felt then that this must have been a very difficult decision.

Since then I have definitely concluded that the interests of both NSPE as an organization and the engineering profession as a whole would be best served were NSPE to become a constituent member of EJC. Here are the fundamental reasons why I believe NSPE should reconsider its previous decision. Actually there are three organizations undertaking to function wholly or in part as the voice of the engineering profession. In addition to EJC and NSPE we also have, of course, the Engineers' Council for Professional Development. While ECPD is identified in the minds of most engineers as a highly regarded curricula accrediting agency, its aims and purposes far transcend accreditation. Basically its objectives are the same as those of EJC.

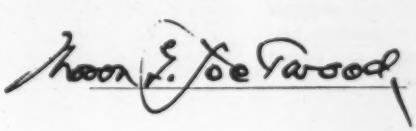
We do not need both EJC and ECPD. Fortunately there is a strong movement for consolidation, a movement with definite promise of early success.

When and if these two organizations are consolidated, a stronger EJC or equivalent of some other name will emerge. Both EJC and NSPE for several years have been growing in membership and influence at relatively satisfactory rates. I think the rate of growth of each may be expected to increase in the future. Thus, as matters stand, the prospect is for two stronger but still divided and frustrated "voices of the engineering profession." Neither has any plans for going out of business. Neither needs to. There is a mechanism for NSPE to become a part of EJC but none for EJC to become a part of NSPE. I am fully convinced that by the exercise of some real professional statesmanship on both sides, NSPE could become a happy and useful constituent society of EJC without sacrifice of identity and with assurance of greater future strength inside than outside EJC.

Engineering not only suffers the ordinary frustrations and heartaches of disunity, it also suffers the deeper pain of wounded pride, because with all our professional intelligence, we have not been able to be objective about the biggest problem of the biggest profession.

This is no plea for patience about our lack of unity. Certainly I am not suggesting that we forget the matter for a generation or so and let it solve itself.

On the contrary, I urge engineers to keep practicing unity assiduously—as they have been—at state and local levels. Moreover, they should literally bombard their governing bodies with their expressed yearning for some kind of genuine national unity. Tell them that the profession is going to have unity. Worry them to death about the matter! Never let up!



President of ASCE

Gated structure

Control structure for Niagara Falls consists of 13 piers with drum-type gates between them, spanned by service bridge.

The crest line of the Horseshoe Falls at Niagara has receded under natural conditions more than 850 ft in 200 years. This has resulted in an increased concentration of water toward the center of the horseshoe and an ever-decreasing flow over the American Falls. It is evident that, if allowed to continue as in nature, this recession would eventually destroy the spectacle of the Falls as we know it today. The governments of the United States and Canada have long studied this problem and are now constructing the Niagara River Remedial Works to preserve the spectacle of the Falls while diverting maximum water for power.

The rate of recession of the crest line has been substantially reduced with the diversion of water from the river for power purposes. However, these increased diversions from above the cascades lower the Chippawa-Grass Island Pool, which reduces the flow over the American Falls. With recession of the crest line, the lowered pool reduces flow over the flanks of the Horseshoe Falls so that at times they become partially denuded. Action to correct this condition has been taken.

Diversion of water for power has been permitted since 1909. When it was stepped up in 1940-1941 to provide more power for war needs, a submerged weir 1,800 ft out from the Canadian shore was constructed in the Niagara River about one mile above the Falls. See Fig. 1. This weir, built of large rocks placed in the river by means of a cableway, substantially compensated for the lowering effect of the diversions on the Chippawa-Grass Island Pool.

The Treaty of February 27, 1950, allows a revised permanent schedule of permissible diversions by which the flow over the Falls may be reduced to not less than 100,000 cfs during the daylight hours of the tourist season and not less than 50,000 cfs at any other time. It is noted that the scenic requirements are thus fulfilled before consideration is given to diversion for power. The treaty also provides for the design and construction of remedial works to enhance the beauty of the Falls by distributing the water so as to produce an unbroken crest line.

The remedial works follow the recommendations made by the International Niagara Falls Engineering Board through the International Joint Commission. These recommendations were based on model studies at Vicksburg, Miss., and at Ontario Hydro's Islington Service Center. The works advocated include: (1) excavations on Goat Island and the Canadian flanks of the Horseshoe Falls to distribute the water over the crest of the Falls in an unbroken curtain, and (2) construction of the Chippawa-Grass Island Pool Control Structure. Each country constructs the part within its borders but the cost of construction

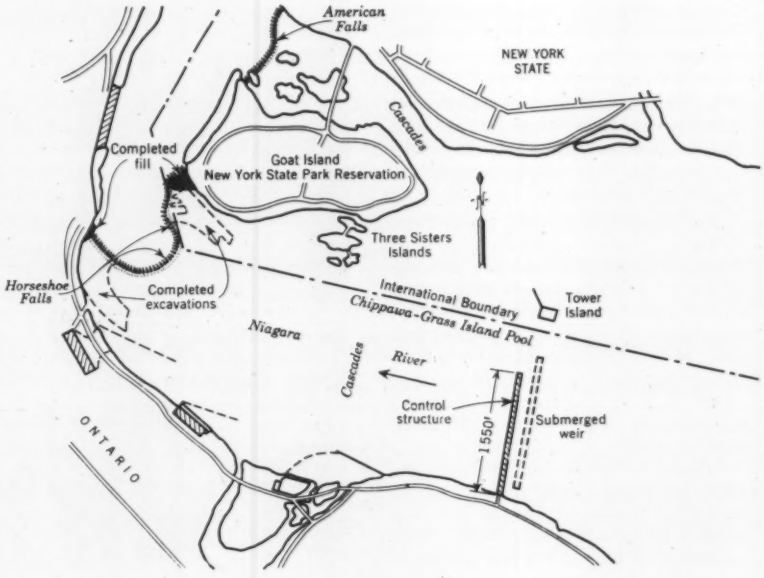


FIG. 1. Chippawa-Grass Island Pool Control Structure diverts and controls flow over Niagara Falls to produce better spectacle, stop recession, and permit greater diversion for power.

controls Niagara flow

OTTO HOLDEN, M. ASCE, Chief Engineer

J. L. SOARE, Project Engineer

The Hydro-Electric Power Commission of Ontario, Toronto, Canada

and maintenance is borne equally by the two countries.

Excavations on the two flanks of the Horseshoe Falls have been completed and are accomplishing their purpose in full measure. Construction of the Chippawa-Grass Island Pool Control Structure is nearing completion.

A comprehensive series of tests on the models showed that an obstruction extending 1,550 ft out from the Canadian shore toward Tower Island would be required to compensate for the most severe diversions, those limiting the flow to a minimum of 50,000 cfs. A gated structure was called for so that, by manipulation of the gates, the river flow could be obstructed or allowed to pass over the Falls, as required. Ice sometimes concentrates in floes that cover the surface of the Niagara River from the United States to the Canadian shore. The control structure is designed to present the least possible obstruction to ice runs to prevent the formation of jams.

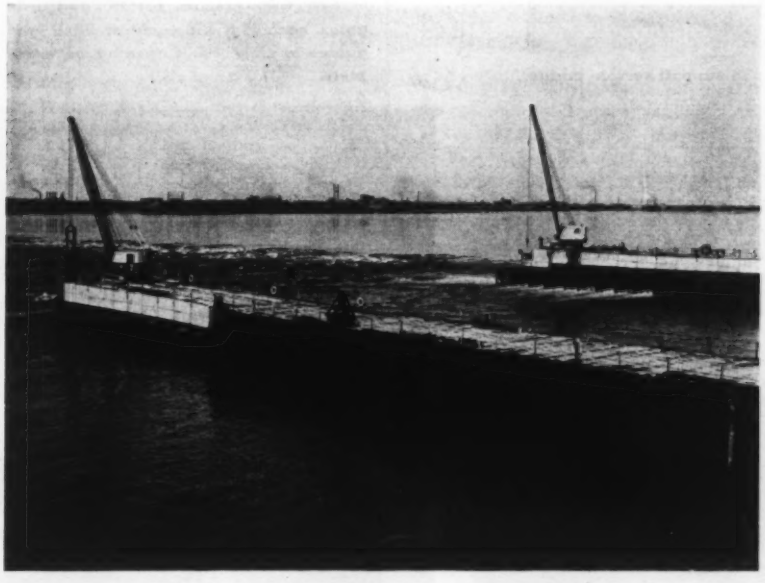
To meet these conditions, the Chippawa-Grass Island Pool Control Structure was designed. It has 13 sluices, each with a clear width of 100 ft, separated by piers 14 ft wide. The rest of the 1,550-ft length is a fill on the Canadian end.

Hydraulic model studies determined that the control structure should be placed in about the same position as the earlier submerged rock weir. It was decided, however, that a location downstream from the rock weir would be satisfactory for it, and that the rock weir would not have to be removed. To avoid interference from the weir, a location 300 ft downstream was selected. See Fig. 1.

Design features

A width of 100 ft was chosen for the sluice openings, this being the greatest width practicable for gate design. A submersible or overflow type of gate was considered most suitable, with a flap design that is hinged at the sill and drops downstream to open. In view of the ice conditions in the river, the specifications required that the gates be able to withstand a pressure of 500,000 lb per gate acting at the crest over any 10 ft of its length. It is further stipulated that a mechanism be provided to release the gates so that they will open automatically should the pressure exceed the design load.

A contract for the design and supply of gates and operating equipment was placed with Canadian Vickers Limited, since this company, working with M.A.N. of Nurnberg, Germany, had offered equipment admirably suited to meet the requirements of the control structure. The gates, now known euphoniously as "fish-belly flaps," are



Upstream and downstream legs of first cofferdam are seen under construction. Method was, first, to drive H-piles through a frame to toe-hold in limestone rock swept clean by turbulent river. Next, frame was loaded with concrete blocks, and finally sheetpiling was driven along outside edge.

structurally similar to drum gates. See Fig. 2.

The drum or body of the gate is secured, at its lower edge, to the sill of the sluice by 18 hinges spaced at regular intervals, which transmit the horizontal loads on the gate into the structure and allow the body of the gate to rotate about the hinge axis. When raised to the fully closed position, the gate extends 10 ft 6 in. above the sill. When lowered to the fully open position, the highest point of the gate is level with the sill of the sluice to present the slightest possible obstruction. Rubber seals on each end act against stainless clad plates embedded in the piers to prevent water from flowing around the gate.

The rollway of the sluice measures 64 ft from the upstream to the downstream edge. The sill at the upstream side, to which the gate is attached, is at the same elevation as the crest of the original rock weir upstream. Downstream the rollway has a bucket shape to disperse the energy in the water flowing through the sluice and so reduce erosion on the downstream rock.

Model tests were carried out by the manufacturer to study the effect of water flowing over the gate in an unbroken curtain. It was found that this condition produced a partial vacuum immediately behind the gate which affected the discharge capacity and increased the force required to operate the gate. This difficulty was overcome by introducing air back of the gates by means of flow splitters on the crest and breather pipes of 20-in. diameter embedded in the piers and extending above the water level.

Each gate is rotated on its hinges by trunnions passing into the piers at each end of the gate, and connected to driving levers inside the piers con-

FIG. 2. Control structure consists of 13 drum-type gates, each with a clear width of 100 ft. Gates when closed rise 10 ft 6 in. above sill, and when lowered are level with sill to avoid obstruction to flow. "Dewatering checks" mark location of removable cofferdam for gate maintenance.

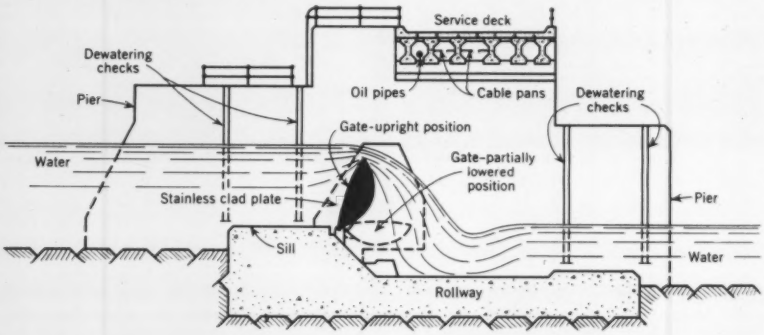
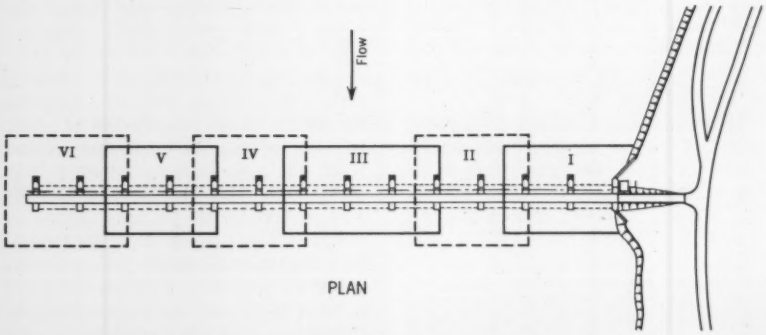
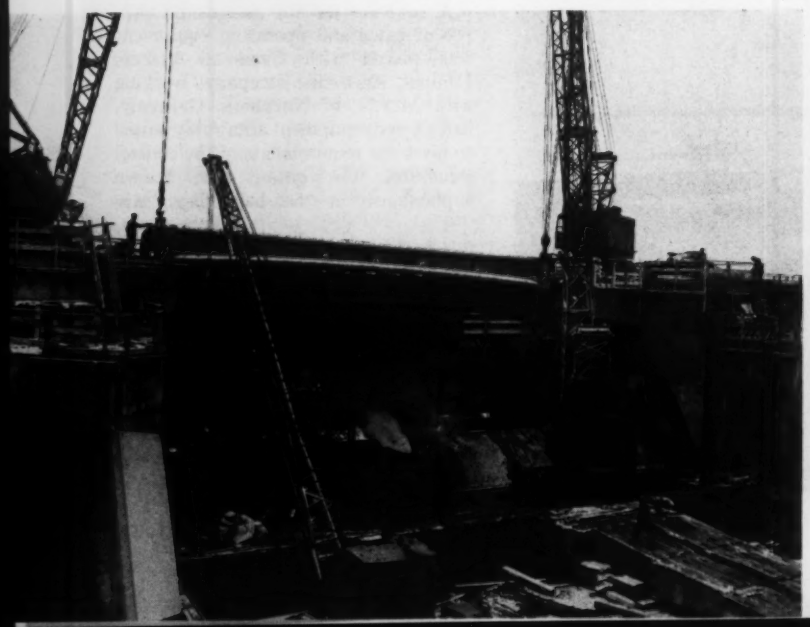


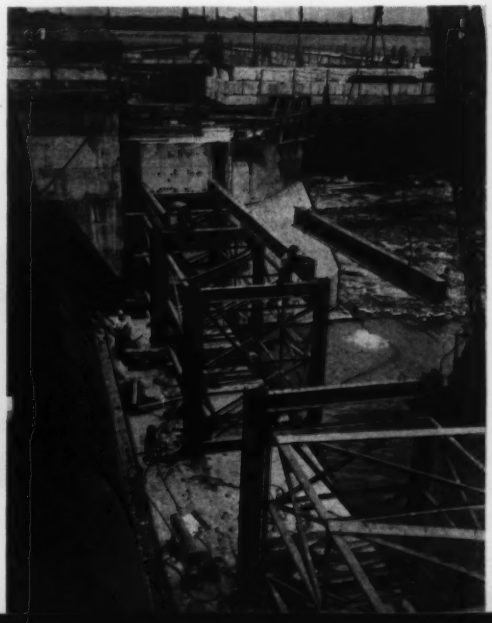
FIG. 3. Two cofferdams were moved out from shore in stages for construction of gated structure. First cofferdam successively assumed positions I, III, and V, and second cofferdam positions II, IV, and VI.



Precast prestressed girder is set between piers to support service bridge.



Unwatering of sluice for gate maintenance will be accomplished by use of steel frames set on rollway, here seen in trial placement. Frames will be loaded with precast blocks, and five gates, each 20 ft wide, will be fitted into guides to close 100-ft opening between piers.



nected to hydraulic pistons. Although the gate is normally operated from both ends, it is sufficiently rigid to be operated from one end under normal hydrostatic load.

Each gate has its own individual hydraulic system. Oil is pumped from a sump tank by a 40-hp motor connected to hydraulic cylinders in adjacent piers to power the pistons and raise the gate. The gate is lowered by releasing oil from the cylinders back to the sump tank. Normal operating pressure in the system is 400 psi, but under conditions of maximum load, the pressure can rise to 1,000 psi. The emergency lowering device called for in the specification is provided by breakable pressure heads. If the pressure in the hydraulic system exceeds 1,000 psi for any reason, the pressure heads rupture and release oil from the operating cylinders through the emergency discharge line to the sump tank. The gate will then drop free, but to prevent damage, its movement will gradually close a valve in the discharge line so that it will move down slowly to the fully open position.

Each gate has a central heating system of 110-kw capacity which, by circulating hot oil to the seal plates on the side of the piers and to the seal and hinge areas, prevents icing under winter conditions. The heating system is automatically controlled by outside air temperatures.

Construction of piers and deck

Each pier supporting the gates is 91 ft long with a sloping cutwater upstream, and is a stable structure capable of resisting an ice thrust of 560,000 lb in addition to hydrostatic loads. It is 14 ft in width at water level and is cantilevered laterally 14 ft on each side over the sills to a total width of 42 ft to form part of the service deck.

The service deck spanning between cantilevers is a concrete girder-and-slab structure. To permit construction within the scheduled time, the girders were precast on the shore and prestressed to reduce their weight and thus facilitate erection. Each span of the deck is made up of six prestressed precast girders with cast-in-place diaphragms and roadway slabs. The girders, diaphragms, and roadway slab are then prestressed laterally to assure proper load distribution. The Stresssteel system of prestressing was used for the girders and lateral prestressing operations.

The service deck is designed to carry a 70-ton crawler crane or to support the loads from a 45-ton crane working on it in any position.

River levels could not be appreciably varied during the construction period. Fortunately, the Sir Adam Beck Niagara Generating Station No. 2 was under construction, and additional diversions from the river could be planned to coincide with the construction of each cofferdam for the control structure. Existing river levels were maintained by carefully scheduling the extension of the structure out from the shore in increments sufficient to compensate for the increasing diversions through the new generating station as units came into service.

Cofferdam on smooth rock bottom

Further hydraulic model studies established that the control structure should be completed in six stages, as shown in Fig. 3. The repetitive nature of the work suggested a cofferdam that could be reused. The bottom of the river was reasonably level and the same height of cofferdam could serve each stage of construction. A rock bottom swept almost clear and smooth made construction in the dry a challenge. But a reusable steel cofferdam was devised that proved eminently satisfactory despite high velocities and turbulent flow in the river.

The shore abutment and two piers were enclosed by the "first-stage" cofferdam. Construction inside this cofferdam proceeded while the second-stage cofferdam was being built to enclose the third and fourth piers. On completion of the first two piers, the first-stage cofferdam was "leap-frogged" to overlap the second-stage cofferdam for construction of the fifth and sixth piers, and water was passed through the completed work. Similarly, the second-stage cofferdam was moved to the fourth position. In this way the work was completed, using each cofferdam in three different positions. See Fig. 3.

Cofferdam construction was carried out as follows. Immediately adjacent to the shore, extending out into the shallow water, a section of cofferdam was built using rock-filled timber cribs of conventional design. Beyond this structure, the unique reusable steel cribs were placed and top-loaded with concrete blocks as shown in a photograph.

A starter frame attached to the outstream timber crib provided guides for the first steel frame, which was set by a crawler crane. Interlocking rollers, fitting into the guides on the starter frame, kept it in alignment. After it was in position, heavy H-sections were inserted into the frame and driven to secure penetration in the river bed. The H-section projecting above the frame was cut off and a cap beam spanning the H-sections fastened into position. The crib was then loaded with 36 precast 6-ton concrete blocks, each 10 × 2½ × 3 ft, resting on the cap beams. Thus the top load is carried solely by the H-sections, and the 10 × 30-ft steel frame acts only as a spacer and aligner, and to distribute the horizontal load to the H-sections.

Steel sheetpiling was driven on the river face all around the cofferdam, penetrating the limestone bed of the river 2 or 3 in. Next an earth fill was placed along the base of the cofferdam to provide a watertight seal. After unwatering, struts were installed to strengthen the upstream leg of the cofferdam against the possibility of extreme ice pressure. Each cofferdam was pumped dry in one day.

Because of the porous nature of the rock, pressure grouting was done before excavation started. This procedure was very successful and little difficulty has been experienced from ground water during construction. All leakage into the cofferdam has been handled by a small pumping unit.

Within each cofferdam, ramps have been constructed to permit easy movement of equipment and materials to the construction area. Since the shoreward sections were built first, the service bridge could be used as a roadway and has served construction adequately. This type of cofferdam also provides a roadway all around the area for equipment. A supplemental trestle, of Bailey bridging, just downstream from the service deck, raised the cranes to an excellent work level. It also permitted shifting cranes to the 42-ft-wide pier tops for setting gates and precast members of the service bridge.

The Hydro-Electric Power Commission of Ontario was designated by the Ontario Government to carry out the obligation of Canada and to act as the Canadian construction agency to build the Chippawa-Grass Island Pool Control Structure. The design of the structure in all its phases was completed by Ontario Hydro with the very helpful and cordial cooperation of the Corps of Engineers, U. S. Army, Buffalo District Office, the United States construction agency. Construction has been carried out by forces of Ontario-Hydro. Design, construction, maintenance and regulation procedures are the overall responsibility of the International Niagara Board of Control, appointed by the International Joint Commission.

(This article is based on the authors' paper presented at ASCE's Buffalo Convention before a Waterways and Harbors-Hydraulics Division joint session, presided over by Roger H. Gilman, a member of the former Division's Executive Committee.)

Prestressing strengthens a

Prestressing as a means of securing economy in the design of a new steel bridge would appear to be of questionable value particularly since such prestressing would involve additional design work and site supervision. However, prestressing as a means of strengthening an existing steel or wrought-iron bridge is another matter, and its advantages for this use are very great.

A case in point is the railway bridge over the River Wye at Monmouth, England. This wrought-iron structure, built in 1876, is 148 ft 6 in. long, of deck truss-girder type. As shown in Fig. 1, the bottom chords of the main girders are of unusual design. The lower box sections were added some time after the original structure was built as a means of strengthening it. Severe corrosion had taken place inside these box sections, since they were not sealed against the entrance of moisture and were not accessible for maintenance. The loss of sectional area in the box sections was the only serious weakness in the truss girders.

The first step in the rehabilitation of the bridge was to cut away the bottom plate on the box sections, and to replace it by lattice angle bracing, as shown in Fig. 1.

Prestressing was accomplished by the use of four high-tensile-strength Stressteel Macalloy bars for each of the two bottom chords, or eight in all. These bars were grouped symmetrically about each chord (two in each side) as shown in Fig. 1. The top two are of 1⅛-in. diameter and the bottom two of 1-in. diameter. They were tensioned between built-up welded mild-steel anchorages secured to the chords near each end. Anchorages are 128 ft apart, that is, about 10 ft 3 in. in from each end of the span. The compressive force thus applied in the plane of the bottom chords was 217 kips on each girder.

End anchorages for the bars were fitted as shown in a photograph. The bars, which were furnished in 14-ft 6-in. lengths, were connected by special screw couplers and were then supported in temporary rope slings. To ensure freedom of movement in the bridge span, the roller bearings at the Chepstow end of the bridge were jacked up and overhauled before prestressing started. It had been calculated that prestressing would shorten the chords about 0.21 in.

The eight bars were tensioned simultaneously by eight Lee-McCall hydraulic jacks. A 4-in. extension was provided. It was calculated that the dead-load stress in the weakest panels was reduced from 7,056 to 896 psi.

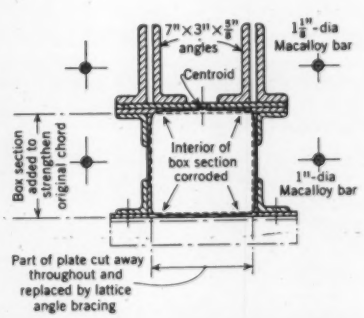

7"×3"×⅝" angles
1⅛"-dia Macalloy bar
Centroid
Box section added to strengthen original chord
Interior of box section corroded
1"-dia Macalloy bar
Part of plate cut away throughout and replaced by lattice angle bracing

FIG. 1. Section through bottom chord of River Wye Bridge shows corroded box section which had been previously added to strengthen structure. Note location of four high tensile steel bars.

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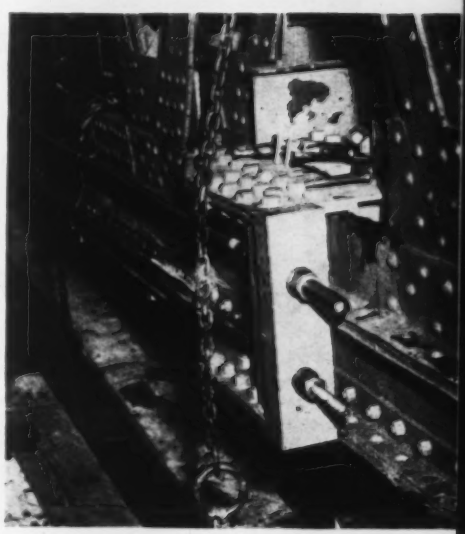
Wrought-iron railroad bridge across River Wye at Monmouth, England, was recently strengthened by addition of eight Macalloy (Stressteel) bars, two at each side of each bottom chord. See view at left. All bars were tensioned simultaneously by eight hydraulic jacks. Sag was reduced by supporting bars at intervals of 14 ft 8 in. by flexible supports hung from brackets, as seen directly below. In bottom view, note anchorage for two bars after prestressing. Chains seen in all three photos support temporary falsework.



wrought-iron bridge

Dial gages measured the shortening of the chords at the girder ends as 0.170 in. on the north girder and 0.181 in. on the south girder. The difference between these recorded shortenings and the calculated value of 0.210 in. was probably due to the stiffness of the gusseted connections of the web members.

The prestressing force had the secondary effect of increasing the camber of the girders by 0.22 in. This camber, recorded by a Cambridge deflectometer, compares with the calculated value of 0.43 in., which was based on the assumption of pin-jointed connections in the girder.

The stress in the weakest panels of the bottom chords before and after tensioning is summarized as follows, in psi:

	Dead Load	Live Load	Total
Before tensioning	7,056	15,680	22,736
After tensioning	896	15,299	16,195

Because of the stiffness of the gusseted web-member connections, secondary stresses were induced in the girders by the tensioning forces. Since these secondary stresses were in the opposite direction to those already acting, the net result was a reduction in the secondary stresses.

To reduce sag in the prestressing bars, permanent flexible supports for them were provided at intervals of 14 ft 8 in. on centers. Upper and lower bars were given separate supports, as seen in a photograph. After the bars had been prestressed, the supports were adjusted so that they would remain firm under the maximum full live-load deflection of the truss girders, estimated at 1 in. By this means chattering and wear at the supports were eliminated.

To protect the bars against corrosion they were wrapped with a plastic-coated tape, and their projecting threaded ends at the jacking end were protected with plastic sheaths.

The design for the renovation of the River Wye bridge here described was prepared by the writer under the general supervision of M. G. R. Smith, Chief Engineer, Western Region, British Railways. (Both are members of the Institution of Civil Engineers of Great Britain.)

In air view of Chao Phya Dam, note four-gate center section through which river was diverted while earth dam at far right was being built across old river channel. Navigation lock is under construction in foreground.

Thailand's Chao Phya Irrigation Dam

The newly completed Chao Phya Project in Thailand will supply irrigation water and control floods to increase the country's rice production by a million tons a year. The project includes canals and three navigation waterways extending for a length of 220 miles from the sea (Fig. 1). It will provide water for 80,000 acres of previously dry land, will irrigate 1,350,000 acres that has previously had only overflow water, and will provide some additional water to 860,000 acres not now adequately served.

Chao Phya Dam, main structure of the project, stores little water but raises it to the required height for irrigation and navigation. It is a reinforced concrete structure 870 ft long with gates to pass 105,000 cfs. A navigation lock has a 46 x 870-ft chamber with a 28-ft lift. The structures have a total height of 67 ft above foundations and contain 180,000 cu yd of concrete.

Cost of the Chao Phya project is about $58,000,000, of which the International Bank for Reconstruction and Development provided $18,000,000. The dam itself cost $7,500,000. Maximum work force on the project was 2,700.

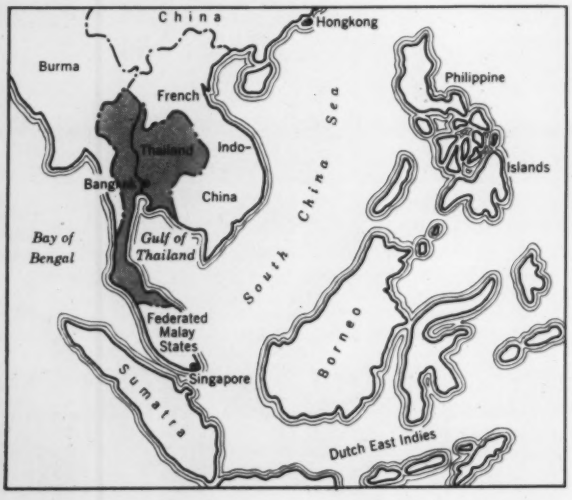
The dam was constructed on dry land in a bend of the river and a discharge channel opened later by dredging. Wellpoints were used to dewater the work area 13 ft below stream bed, requiring pumping of about 7,500 gpm for the greater part of a year. A steel sheetpile wall, driven through sand to impervious material, provides a water cutoff under the structures.

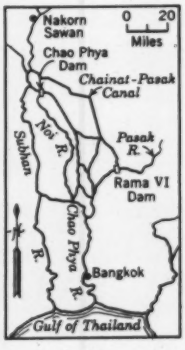
The spillway of the dam consists of 16 identical radial gates each 41 ft wide, separated by piers 8 ft wide, making the total width 780 ft. The gates are 24.5 ft high and have electrically operated hoists located on a reinforced concrete service bridge. The gates can also be operated manually if required.

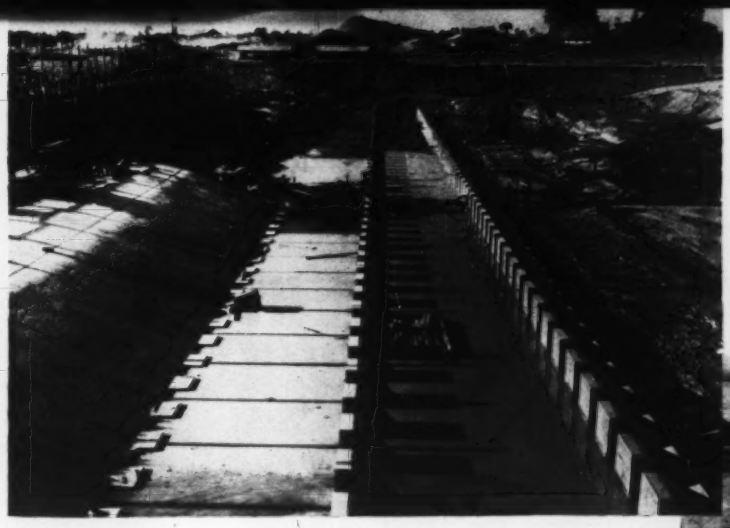
A reinforced concrete highway bridge, designed for a double-lane 20-ton truck loading in accordance with the AASHO specifications, spans the tops of the piers for access across the spillway. A structural steel double-leaf bascule bridge carries the highway across the navigation lock. The bascule bridge is electrically operated, but can be operated manually in an emergency.

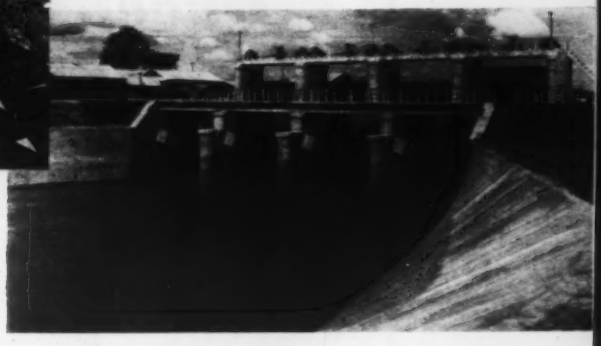
A unique construction feature of the dam was that the central four radial-gate sills were initially constructed 13 ft lower than the sills of the radial gates on each side. The river was then diverted through this low section in the partially completed dam to facilitate construction of a rolled earth closure dam across the old river channel.

FIG. 1. Thailand is shown shaded on map of Indochina. Detail gives outline of Chao Phya irrigation and navigation project, with principal channels indicated.









Apron and stilling pool of Chao Phya Dam are seen at left, under construction in December 1955. Regulating structure—seen from downstream in view below—controls flow from Chao Phya River into Noi River channel for irrigation and navigation. Four top-seal radial gates are each 20 ft wide.

AUGUST L. AHLF, M. ASCE

Project Engineer, Irrigation and Drainage, Tippetts-Abbett-McCarthy-Stratton Engineers, Inc., Baghdad, Iraq; formerly Engineering Adviser to Royal Irrigation Department, Bangkok, Thailand, on loan from U. S. Bureau of Reclamation

After the earth dam was completed to several meters above the elevation of the spillway crest, the four low-level gate openings were closed by a temporary needle dam. An ogee crest of reinforced concrete 13 ft high was built into the low-level openings to raise them to the same elevation as the rest of the spillway section. The radial gates in the central raised section are the same as the other spillway gates.

Provision has been made to install emergency structural-steel bulkhead gates both upstream and downstream of the radial gates should future repairs be required. This was considered necessary since a great number of large teak log rafts must be passed through the navigation lock each year, and damage to the gates may result should a raft get out of control or an individual log strike the gates.

The 46 x 870-ft lock chamber was proportioned to accommodate these teak log rafts. Lockage through the basin is controlled by a pair of double-leaf miter gates 47 ft high on the downstream end of the lock and 24.5 ft high on the upstream end. The electrically operated gates can be manually operated in an emergency.

A precast concrete pile jetty constructed on the right side of the upstream end of the navigation locks provides a place where boats can load and unload passengers and goods, and also where teak log rafts can be tied up while awaiting their turn through the lock. A similar jetty has been provided on the left, or river side, to prevent boats and rafts from being swept by the current into the radial gates.

Little firm power is available as the tailwater rises almost to the headwater elevation for two months or more in the year. A 300-kw hydroelectric generator is supplemented by a diesel unit for gate and bridge operation.

Irrigation and navigation facilities

Each year during the flood season the existing channels of the Noi and Suphan Rivers carry a considerable quantity of the Chao Phya's flow. See Fig. 1. These channels will be utilized to serve as two of the three main distributing canals. The third major channel, the 75-mile-long Chainat-Pasak Canal, is being constructed from a point upstream from the Chao Phya Dam to a point upstream from the existing Rama VI Dam on the Pasak River.

The three channels not only serve as main distributary canals but also provide navigation routes that can be used for the entire year from Bangkok to Nakorn Sawan. Vessels 20 ft wide with 6.5-ft draft can be accommodated. Twelve navigation locks and twelve large regulating structures have now been constructed for the three canals. Three of each of these structures were constructed on the Suphan River prior to the present construction program, but one navigation lock has required extensive reconstruction work.

In addition to the three major canals, a network of irrigation canals is being constructed to serve irrigable areas. These canals range in size from the 7,400-cfs Chainat-Pasak Canal having a base width of 170 ft, to small laterals only a few feet wide. The largest channel, the Suphan River, has the capacity to carry a flow of 11,000 cfs during the time the Chao Phya River is in flood. Although the canals are primarily for irrigation they provide for small-boat transportation. The canal banks are to be surfaced and used for land transportation to areas now largely inaccessible.

Organization

The construction of the Chao Phya Project, including the dam and navigation lock, is being carried out by the forces of the Royal Irrigation Department of Thailand under the direction of Mom Luang Xujati Kambhu as Director General. Nai Xu Prabhasthita is Chief Engineer for the project, Nai Kanok Pranich, J.M. ASCE, is Superintending Engineer, and Nai Fu Anusasananandha is Chief Engineer for the irrigation system. Technical assistance on the construction of the dam and navigation lock is provided by Keir and Cawder Company of Glasgow, Scotland; Kenneth Child is General Manager.

All engineering for the dam, navigation lock, canals, and other structures is being done by the Technical Division of the Royal Irrigation Department under the direction of Khun Jantra, head of the division. The writer, on loan from the U. S. Bureau of Reclamation, was Engineering Adviser to the Royal Irrigation Department from 1951 to 1956. Maurice E. Day, also on loan from USBR, was Engineering Adviser from 1951 to 1953.

Prestressed wind bracing in Queen Elizabeth Hotel

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Overcoming wind forces in a tall, narrow building has always presented certain difficulties. The Queen Elizabeth Hotel in Montreal, being built by the Canadian National Railways over its railroad station there, is no exception. The structural designers found it necessary to develop some type of adequate wind bracing system which would meet the architect's requirements by fitting inside thin partitions, and which would pose no danger of damage to the partitions by bars going into compression under maximum wind load.

The Queen Elizabeth Hotel is a 21-floor building with a two-story penthouse. Below the main floor are three levels—the lower level, the station level, and the track level. On the track level, about 55 ft below the main floor, trains pass under the hotel (and under the station concourse on the level immediately above). Dining rooms, banquet rooms and convention halls are on the second and third floors of the hotel. Above the third floor are the bedroom floors, which are all similar in plan.

Bracing problem studied

Original design investigations were based on a rigid-frame building with moment connections on all beams to take the wind forces. Note in Fig. 1 that in the unusual floor framing there is no direct tie between the two interior columns, and consequently that the wind must be taken by two single-bay towers instead of by one three-bay tower. This design would have made the beams very deep and the moment connections very wide in order to provide room for the required number of tension rivets. Architecturally, deep and wide beams were undesirable for upper floors because there were to be no hung ceilings in the bedroom floors, and large beams would mar the appearance of the wall. Hence moment connections were rejected for the bedroom floors but retained on the lower floors, where large beams were not objectionable.

Among the ideas considered to solve the problem of bracing was that of having one wing of the building support the other through the concrete floor slab. This method has been used successfully in many cases but did not prove too satisfactory in this case because of the L-shape of the structure and the break in the slab for elevator shafts at the highly stressed inside heel of the L. See Fig. 1.

Angle or channel bracing members were suggested but the resulting partition thickness would have been about 12 in. as compared with the 4-in. thickness of the standard non-braced interior partition. In an endeavor to obtain a narrow partition, the architects made a thorough study of concrete shearwalls.

Such shearwalls would be of reinforced concrete, poured in two pours to form, with the floor slab, a section cruciform in elevation. The partition thickness resulting from the use of shearwalls would be 6 in. on the bedroom floors.

Shearwalls would however have some disadvantages, among them that:

1. They would restrict future alterations in the building.
2. They would have to be interrupted between the tenth and eleventh floors to allow for the passage of large air-conditioning ducts above a hung ceiling, there being a larger floor-to-floor dimension there than on the other bedroom floors.
3. The dead load on the footings and columns would be very substantially increased.
4. Pouring delays would result because of the construction sequence of walls and floors.

In the steel framing of the building only a nominal stiffness is provided by the beam connections, which are of the moment type and designed for the relatively shallow depth of the beams. About 5 percent of the wind on the finished building could be taken on these beam connections whereas about 45 percent of the total wind force would act on the bare steel structure. It became evident that the pouring of the concrete shearwalls would have to follow closely behind the erection of the steel structure if major erection bracing were to be omitted. Because steel erection can proceed more rapidly than forming and pouring of concrete, it was felt that temporary erection bracing would be necessary so as not to interrupt the erection procedure.

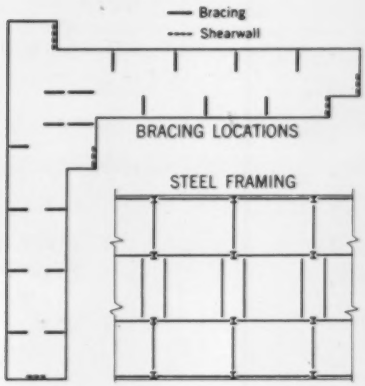
Considering the abundance of temporary erection bracing required, it appeared more and more unlikely that the shearwall solution would be economical. Therefore a system of steel bracing was decided on, using steel-plate bracing bars varying in width from 6 to 8 in. and in thickness from $\frac{3}{4}$ to $\frac{7}{8}$ in. Details were devised so that this bracing could be used as temporary construction bracing and later pretensioned as permanent bracing. To enclose this bracing in a thin wall, it was necessary to pretension the bars to a point where no bracing bar would go into compression with maximum wind acting on the structure. This enabled the architects to enclose the bracing in a narrow partition without danger that the walls would be cracked.

The partition is composed of 2 in. of plaster-faced wall material, 2 or 3 in. of air space for the bracing bars depending on bar thickness, and another 2 in. of wall material—a total partition thickness of 6 or 7 in. See Fig. 2.

Concrete shearwalls were used only

Queen Elizabeth Hotel, in Montreal, Canada, being built by Canadian National Railways over its railroad station, is scheduled for completion early in 1958.

FIG. 1. Section through typical bedroom floor gives locations of prestressed bracing and shearwalls. Note L-shape of building. Partial section shows steel framing for upper floors.



in exterior walls and in some cases around the elevator shafts in the lower floors. In general, shearwalls were replaced by pretensioned bracing bars. Locations of bracing panels and shearwalls on the bedroom floors are shown in Fig. 1.

Pretensioning methods

Two methods of prestressing wind bracing have recently been used in buildings. The first involves heating the bar after both ends have been fastened, and then applying a compressive force on the heated length sufficiently large to upset the bar. Finally the heated length is allowed to cool while the compressive force is still acting. This method is common practice in bridge work for tightening eyebar truss members. Its main disadvantages are lack of flexibility in adjusting stress after the upset has been made, and poor adaptability for use in a temporary construction bracing system before final prestressing is carried out.

Equipment sometimes used for this method is shown in Fig. 3. It consists of two clamps which are fastened to the bracing bar. When the length between the clamps has been heated by a torch until it becomes cherry red, the clamps are drawn together with two bolts until the required upset is obtained. The clamps are kept in place until the bar has cooled, and the result is a tensioned bar with a visible upset.

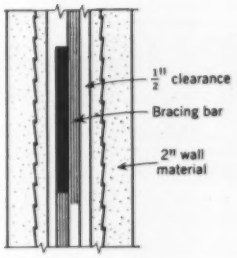


FIG. 2. Typical partition, seen in cross section, consists of 2 in. of plaster-faced wall material on each side of 2 or 3 in. of air space for bracing bars—total thickness of 6 to 7 in.

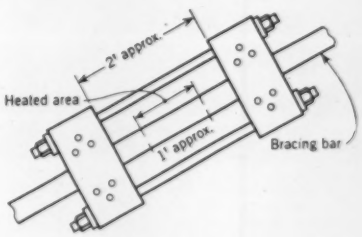


FIG. 3. Equipment of type frequently used for shortening bars by upsetting is shown. Different method was used on Queen Elizabeth Hotel, where both bars in panel were heated simultaneously and free end of each was clamped when required elongation was obtained.

In the second method, that used on the Queen Elizabeth Hotel, the bar is heated and a free end is clamped when the required elongation is obtained. The result after cooling is a tension proportional to the measured elongation.

When the bars were initially erected, they acted as temporary erection bracing. A typical bracing panel detail is shown in Fig. 4. The gussets were shop riveted to double channel beams framing between columns. These columns

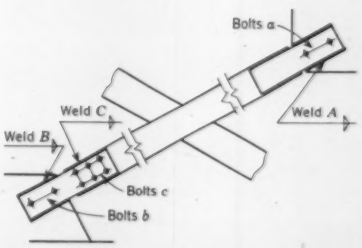


FIG. 4. Bars acted initially as temporary erection bracing and later were prestressed to act as permanent wind bracing. See text for sequence of operations.

Since both bracing bars in a panel were heated simultaneously, two heaters were required, here seen in place on a panel.

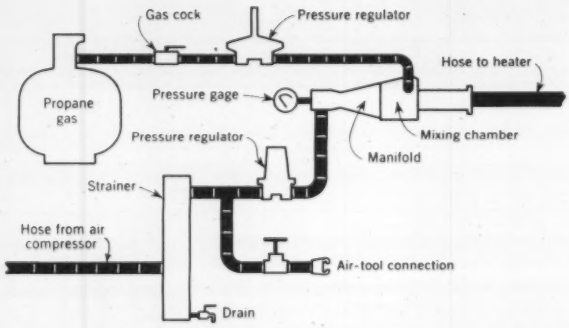


FIG. 5. Heater used for prestressing bars burns propane gas mixed with compressed air. Mixing arrangement is illustrated in diagram. For easy movement, a complete heating unit is assembled as a two-wheeled buggy.

had shop-connected angles to which the gussets were field welded. The upper jaw plates were shop welded to the bracing bar. Both gussets and jaw plates had assembly holes punched for field erection. The bar was erected and loosely bolted to gussets at top and bottom with $\frac{7}{8}$-in. bolts *a* and *b* (in Fig. 4). With the columns plumbed, the gussets were welded to the column connection angles, and bolts *a* were tightened.

The lower jaw plates were then pushed down as far as allowed by bolts *c*, which were of $\frac{3}{4}$-in. diameter in holes of $\frac{15}{16}$-in. diameter. Bolts *b* allowed this movement of jaw plates as the holes in the gussets were of $1\frac{3}{16}$-in. diameter, while the holes in the jaw plates were only of $\frac{15}{16}$-in. diameter. Bolts *b* and *c* were tightened and the jaw plates were welded to the gussets at top and bottom—welds *A* and *B*. This erection procedure provided a miss-match of holes by about $\frac{1}{8}$ in. between the lower jaw plates and the bracing bar. To obtain an initial tension as temporary erection bracing, these holes were drifted with drift pins of $\frac{15}{16}$-in. diameter and bolted with suitable bolts, *c*. This provided an active system of wind bracing which kept the building in plumb during erection and until the prestressing operation could commence.

Steel erection had been completed by the time the general contractor started to pour the lower floor slabs. When the pouring of floors had reached the tenth floor, the pretensioning procedure began.

Prestressing was carried out one panel at a time, one floor being completed before the next was started. It was also important that the prestressing be carried out under a poured floor, as will be explained later.

The field prestressing procedure was as follows. Bolts *c* (in Fig. 4) were removed at the lower ends of a pair of bracing bars, and the bars were supported against displacement between the jaw plates. If a bar was bowed, it was brought back into line with drift pins, care being taken not to introduce appreciable stress. A dial indicator was placed at the free end of the bar and set to zero. Heaters were placed over the upper halves of the bracing bars, and the bars were heated until the desired elongation was obtained. High-strength bolts were then inserted and tightened to hold the tension in the bracing bar developed by cooling. The weld *C* was then made for the full capacity of the bracing bar, and all the bolts were removed.

Equipment used in prestressing

Both bracing bars in one panel must be pretensioned concurrently, and consequently two complete sets of equipment were used, as seen in a photograph. Each heater unit is mounted

Measuring device is in place on lower end of a bracing bar.

High-strength bolts are placed on a heated bracing bar (above). A day or two later, welded connection is made (below).

Stress in each bar was confirmed by extensometer readings, taken with 10-in. Whittemore strain gage.

on a two-wheel buggy to facilitate easy movement from place to place. The buggy is a pipe assembly which supports the gas bottle, manifold, and necessary valves and pressure regulators. Above the manifold is a cradle where the heater unit can be placed when not in use.

Propane gas mixed with compressed air is burned in the heater. A schematic layout of the mixing unit is shown in Fig. 5. Compressed air enters the system through an air strainer and a pressure regulator to the manifold. Immediately following the air strainer is an outlet and valve which permit the connection of other air-operated tools. The propane supply is from a small cylinder mounted on the buggy. The gas passes through a control valve and a pressure regulator into the mixing chamber, which is part of the manifold. Here the gas and air are mixed and flow under pressure through a flexible hose to the heater unit.

The heater unit itself consists of two banks of 34 blast tips facing each other. The tips are mounted along two pipes of 1¼-in. diameter, these pipes being enclosed in a cylindrical steel box about 4 ft long, slotted so that it can be placed over the bracing bar. The heater is so constructed that when it is placed over the bracing bar, the jets are protected from the wind and the heater area is shielded to minimize heat loss and to control the cooling rate.

A cradle type of support at the lower end of the bracing bar keeps the bar in line between the jaw plates while allowing free movement in the direction of expansion. The measuring device used was a dial indicator reading to thousandths of an inch. This indicator on its stand is clamped on the bracing bar, and its plunger works against an arm connected to the gusset or fixed end.

With a heater unit on each of the two bracing bars in the panel, and the temporary bolts *c* removed, a dial indicator was put in place on each bar and set to zero. Both heaters were then lighted simultaneously with a small gas torch. Expansion of the bars was watched on the dial indicators, and heating was continued beyond the required elongation to allow time for any reaming that was necessary and for insertion of the high-strength bolts. When the bars had cooled to the required elongation, the bolts were tightened by air-operated impact wrenches and then checked with a torque wrench to provide the recommended bolt tension. Both impact wrench and reamer are operated from the air outlet on the heater buggy. Thus only one air line is required from the air supply. Air was supplied by a 210-cfm compressor on the main floor, with an air reservoir located higher up in the building.

After cooling, the bolted connection held the bracing bar firmly because of the frictional effect of the high-strength bolts. The welded connection was usually made a day or two later to allow for complete cooling and a check of stress by a Whittemore strain gage before the final connection was made.

Stresses carefully measured

After pretensioning, the desired stress in each bracing bar was 16,000 psi, made up of 10,000 psi for wind stress, 4,000 psi for dead-load column shortening, and 2,000 psi of residual tension under maximum wind load.

An initial reading was taken before the bracing bar was heated but after the bolts were removed at the lower end, releasing the erection tension. The final reading was taken after the bar, held in its expanded position, had fully cooled. Two sets of readings were taken on each bar, one on each side, and averaged to give better accuracy. The difference in readings between final load and zero load gave the elongation in the measured length from which the resulting stress could be calculated.

The effect on the surrounding structure of tensioning a bracing panel is a shortening of adjacent columns and beams above and below. Column shortening is also caused by the addition of dead load on the structure above. Since pretensioning followed closely behind the pouring of concrete floors, some provision had to be made for column shortening due to the increasing dead load. These operations, however, were always carried out under at least one poured concrete floor, so that the concrete floor slab would act with the steel floor beam to form a composite strut.

In the beginning, the shortening of columns and beams due to the tensioning of bracing bars was assumed to be negligible. It was found in practice, however, that there was about a 10-percent drop in stress from that calculated for any given elongation. Therefore the calculated elongations were all increased by this amount, which proved satisfactory. The reasons for this drop in stress could have been an elongation in the gussets and jaw-plate connections as well as the shortening of columns and beams.

As for the 16,000-psi stress originally introduced into the bracing bars, a gradual decrease was noticed as dead load increased. Two test panels on the

fifth floor were checked daily and records kept of the stress in each bar.

The test conditions were not like those found in a laboratory. The daily variations expected, as a result of additional dead load and the effect of tensioning a panel directly above the test panel, were distorted by weather conditions. However the trend showed a fairly consistent decrease in stress of about 2,000 psi due to column shortening by the time prestressing was completed. By this time all the concrete floors and the beam and column haunching had been poured, and about 15 of the 21 floors of stone-faced exterior walls had been completed. The remaining 6 floors of exterior walls, all the interior partitions, and the floor finishes had yet to be installed.

It is felt that the estimated stress of 4,000 psi due to column shortening will be realized by the time the building is completed, early in 1958. Therefore the stress in both bracing bars in a panel under zero wind force will be 12,000 psi. Under maximum wind, both bars will still be in tension—one stressed to 22,000 psi and the other to 2,000 psi.

The method of making the bottom connection of the bracing bar was closely watched by means of extensometer readings. It was discovered that after a high-strength bolt had been used several times, its effectiveness in holding the stress in the bar began to decrease. Therefore it was decided to use new bolts after the second use and to apply a constant torque to all bolts. This decision eliminated the loss in stress previously observed. The procedure for making the welded connection required a tack weld at the toe of the jaw plate before the regular upward weld pass was made. By this means any slippage that might have been caused by weld heating was easily observed.

The Queen Elizabeth Hotel was designed by the Architectural and Engineering Departments of the Canadian National Railways. Associate architects were Holabird, Root and Burgee. The Conrad Hilton Hotel Company will operate the hotel on behalf of the Canadian National Railways.

Steelwork was designed, fabricated, and erected by the Dominion Bridge Company Ltd. under a direct contract with the Canadian National Railways.

(This article is based on the paper presented by Mr. Chamberlain, a Junior Member of the Engineering Institute of Canada, at the ASCE Buffalo Convention, before a Structural Division session presided over by George S. Vincent, a member of the Division's Executive Committee.)

Can we afford

Can we afford the public construction needed in the United States? Will the economy be disturbed by a substantial increase in expenditures for roads, schools, hospitals and water uses? A quick review of conditions since 1930 sets the stage.

The 1930's were years of depression. Tax collections did not provide adequate funds to keep abreast of public construction needs. The early 1940's were war years and all materials were preempted for defense. The late 1940's was a period of shortages, particularly steel, which further delayed public construction. By the early 1950's the cost of construction had risen to the point where it had a retarding effect on public works.

By the mid-1950's it seemed that we were getting a good start in making up this serious deficiency. But now, in the minds of at least some of the public, there is a growing fear that heavy government spending will be inflationary and therefore must be curtailed.

Today our country has a backlog of seriously needed public construction that totals 200 billion dollars. This is the estimate of Gerhart Colm, of the National Planning Association, Washington, D. C. During the past few years our federal, state, and local governments have been constructing public works at the rate of about 10 billion dollars a year. At this rate we will be caught up in 1977 with what we needed in 1957, but in the meantime our population will have increased by 1½ percent per year and we will still have a 20-year backlog. To further blacken the picture, if the "low-government spenders" get their axe into federal, state and local budgets, it can be expected that new works will be among the first items cut. This condition is of such importance that a courageous attitude is indicated not only by our country's leaders but also by all our people.

The position of the United States today in leadership of the free world stems directly from our strong and growing economy. This position of strength during the cold war must be maintained as a first priority. To perpetuate our economic health it is necessary to:

Maintain public support of government
Retain the buying power of the dollar
Conserve national resources
Avoid price control and supply regulation
Preserve work and management incentive
Continue expansion of the industrial base
Maintain rising living standards

Although all these points are vital, preservation of work and management incentive is probably the most important. From such incentive comes our high worker productivity and hence, our economic power. For example, in a country such as Portugal where the worker productivity is at about the level of worker requirements for existence, the country has no marginal economic resources to draw on for development or defense. In a country such as ours, where the worker productivity far exceeds subsistence levels, there are ample economic resources to be used as the people direct.

In a free economy all changes must be gradual. A change of as much as 5 percent of our gross national product in one year would be most disruptive to our economy. Consequently our construction budget should not be raised or lowered by as much as 10 billion dollars in any one year.

Limits on government spending

Several reputable economists have studied the permissible limit of government spending with a view to possible increases in defense expenditures. (The same reasoning applies to increased public construction expenditures). They generally agree that:

We have not reached the limit of government spending permissible while

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more public construction?

still preserving our dynamic economic growth.

The procedure of estimating by percentage increases on past records is recommended.

Increases should be made in relatively small increments. (But there is quite a spread on what is a relatively small increment.)

The recommended estimating procedure is portrayed in Fig. 1. In summary it is as follows:

1. The U. S. Gross National Product (GNP) is projected forward at the rate of 3 percent per year. This is quite conservative. Last year our GNP increased 4½ percent, and since 1949 it has increased 59 percent of the 1949 base, or about 6 percent per year.

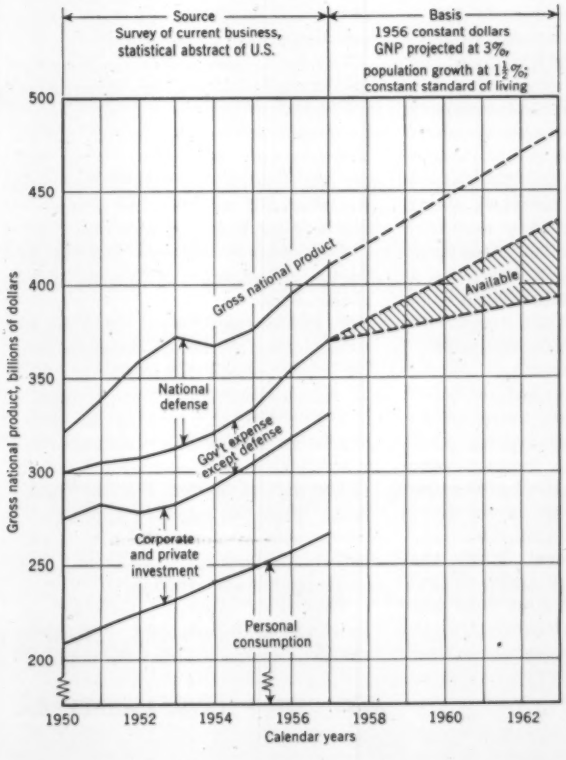
2. Population growth is projected forward at 1½ percent per year. This is about the median of U. S. Census Bureau estimates.

3. The standard of living is held constant. This is the enigma of the estimating process. As stated above, a rising standard of living is one of the criteria for a growing economy in a free country. But it is assumed that the standard of living can be held constant to determine that part of our economic strength which can be divided between increasing standards of living and other purposes.

4. Personal consumption (food, clothing and similar items) is projected forward at the same 1½ percent as the population growth.

5. Defense expenditures are contin-

FIG. 1. Permissible limits of government spending are estimated by percentage increases over past records. The question is, how much of pie marked "available" can be utilized for public construction?



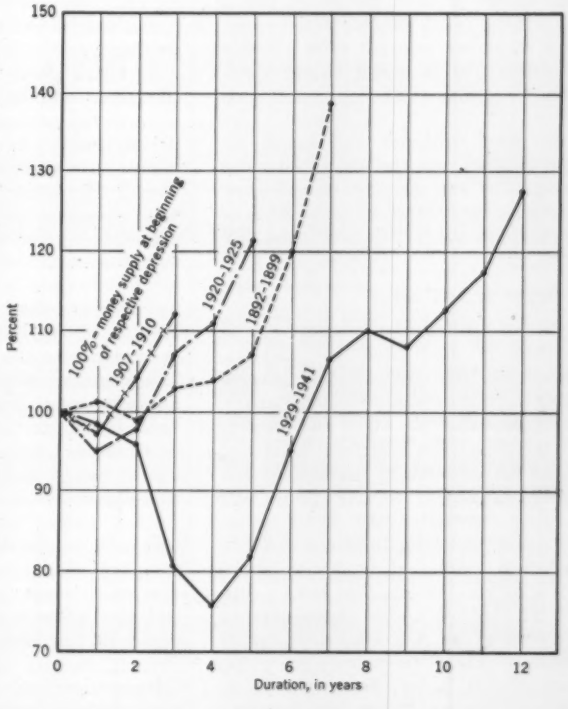


FIG. 2. Money supply is plotted for four depressions. Actually depressions are not caused by the supply of money but by its circulation—or lack of it.

ued at the present level of about 42 billion dollars a year. The end of the cold war is not foreseeable in the next 10 to 15 years.

6. Corporate and personal investments must be continued forward at the same 3 percent as the growth of the GNP in order to provide the expanding industrial base needed to support the growing economy.

7. This leaves only non-defense government expenditures out of the picture. These expenditures include the administrative costs of the federal, state and local governments plus the subject of this article—public construction. Administrative costs should remain relatively stable. The Second Hoover Commission estimated that 4 to 6 billion dollars a year could be saved. Most of the Hoover Commission's economic recommendations have already been adopted. However, the increasing population will require additional administrative expenditures, such as fire and police protection, which will offset any savings in the next 10 to 15 years.

This brings us to the climax of our analysis. How much of the pie marked "available" in Fig. 1 must be allocated to increased living standards to retain our economic growth and how much can be utilized for public construction?

The real "clincher" that is not fully understood by our people is public construction—schools, hospitals, roads, and water services. All these directly contribute to increased living standards. Conceding this conclusion, it is up to us Americans to decide whether we want good education and health for our children and the ability to move around in our country on adequate highways or whether we want 30 lb of chrome on every car and color TV now.

Inflation and deflation

In all economic discussions one is continually confronted by dogmatic statements that taxation and government expenditures are too inflationary. It is important to know the answers in this field. The superficial answer is that the amount of money in the hands of buyers seeking goods and services determines the trend of inflation or deflation. If money is short, deflation results; if money is abundant, inflation results. The money supply in the four major depressions in the history of the United States is shown in Fig. 2 to indicate the influence of this factor. Today the U. S. Federal Reserve Board has complete control of the country's money. By varying interest rates and purchase or sale of bonds, it can closely control the amount of money available in the hands of buyers.

Unfortunately it is not the amount of money available but the rate of circulation of money that affects our economy. To analyze this we will consider some periods of inflation and depression.

On June 25, 1950 the North Koreans attacked the South Koreans. The U. S. public feared rationing and price control. There was a buying spree. Cost of living rose significantly between July 1, 1950, and January 1, 1951. The effect of military buying in this period was insignificant because of the time delay in placing contracts. Between January 1, 1951, and December 31, 1953, the cost of living increase was negligible. Yet defense spending increased from 20 billions to 53 billions a year. To summarize:

1. The inflation occurred through fear, when defense expenditures were relatively low.

2. The U. S. economy showed the ability to carry out a limited war by expanding its defense expenditures by 150 percent without rationing or supply control (except for limited price-plus-fixed-fee government contracts and priorities on government contracts, particularly for steel and aluminum).

3. The cost of living remained relatively constant during the period of higher defense expenditures.

4. There were no unsurmountable shortages.

As Fig. 2 shows, our 1929 bust was the largest and longest. Again the reason was not the supply of money but its circulation. All during the 1920's worker productivity increased rapidly. During that period we introduced the first chain-line production, the first organization of primary and subsidiary manufacturers, and business management got its first start. If labor unions had been organized to the point where they are today, the 1929 crash would never have happened. They were not. The increased benefits of labor productivity went into the hands of a limited number of industrialists and stockholders who put their money into stocks, bonds, and other non-productive, non-circulating assets.

As a result, buyers had no funds with which to purchase products, and companies had to stop making products that didn't sell. Workers were laid off. Defense expenditures were reduced to less than the income from the tax on gum and cigarettes. The cycle ran its full course. Today the labor unions are strong enough to prevent this sequence of events from getting started. Actually their strength has increased to the point where their power in inflationary, and the legislative branch is conducting hearings in an attempt to make them more responsive to public needs.

At this point I quote C. Canby Balderston, Vice Chairman of the Board of Governors of the Federal Reserve System, who states, "The problem of protecting the purchasing power of the dollar is like a three-legged stool. It requires the combined action of general monetary policy and of prudent decision-making by labor leaders, business executives, and consumers. Each businessman and purchaser must regard himself as a trustee of the whole community." ("Buying Power of the Dollar Is at Stake," *U. S. News and World Report*, Oct. 26, 1956.)

Attitude of the people

Any such analysis finally arrives at the conclusion that the U. S. economy can support any program the people want.

The present tax load for public construction amounts to $59 per capita per year. If this were doubled it would mean that the average family provider, with his family of 3.5, would carry a tax load of $413 a year for public construction alone. Will the U. S. public support such a load? It is my firm belief that they will if they recognize the need and realize that they have the capacity. The record shows that since 1941 the income of the average U. S. family has increased 150 percent, living costs have increased 88 percent, and federal taxes have increased 440 percent. The net change represents an increase in living standards of 25 percent.

Our forefathers, with their hardships and strenuous way of life, demonstrated that they had the courage to meet national problems. Our present national wealth and easy way of life can lead us into apathy and selfishness unless we retain the strength and courage of our heritage. It is concluded that:

1. The U. S. economy has the capacity to provide all needed public construction.

2. Public construction could be increased from 10 billion dollars a year by small annual increments to reach 20 billion dollars a year in 4 years.

3. The buying power of the dollar can be protected, but it appears that it will take a more courageous attitude on the part of the people of the United States than the negative approach to government spending which is apparently approaching, particularly for needed public construction.

The views expressed here are my own, and no indorsement of them by the Department of Defense is implied.

Roman Builders of the Republic—Part 1

J. K. FINCH, M. ASCE

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It is surmised that, not long after the Greeks pushed southward into the Greek peninsula, another invading group of Indo-Europeans was forcing out earlier dwellers in Italy. The strongest tribe of these newcomers, the Latins, who occupied the Tiber area, were destined, before the beginning of the Christian Era, to become the masters of the Ancient World. While the Greeks had settled among long-established outposts of the earlier oriental civilization, these Italic settlers had to build from the ground up and had to fight off three other groups.

Later Roman historians dated events *ab urbe condita,* from the traditional founding of Rome about 750 B.C. It seems probable, however, that for some 250 years after this date Rome was dominated by Etruscan kings, the rulers of a group of sea-raiders of still unknown but probably eastern origin. To the south, in the foot of the "Italian boot" and in Sicily the Greeks also had established colonies as early as 750 B.C. These Greeks greatly aided the early Latins by breaking the sea power of the Etruscans while they also held in check the third group, the Carthaginians, in north Africa. By 350 B.C., this Greek role in the birth of a new nation had been accomplished. The Greek outposts had declined in vigor and were taken over peacefully by the Romans, leaving only the third group, Carthage, to dispute the control of the West. This struggle ended in 146 B.C. with the complete destruction of Carthage by Roman forces.

Roman history may be divided into two major periods—the Republic from about 500 to 31 B.C. and the Empire from 31 B.C. to the fall of the Western Roman Empire in the 5th century A.D. The Republic marked the Age of Conquest, and following the destruction of Carthage, Rome became, in the 2nd century B.C., mistress of the Ancient World. Her control extended from Egypt and Asia Minor to the British Isles. It was an age marked by a ruthless exploitation of Rome's far-flung colonial possessions. In sharp contrast, the advent of the Empire brought 200 years of relative peace and witnessed the extension into the colonies of the public works—buildings, roads, bridges, water supplies—which had been basic to the earlier development of civilized life in Italy. Thus one looks to Italy for the earlier Roman engineering achievements but finds in other areas—France, Spain, North Africa, and the Near East—many interesting examples of later Roman engineering skill and progress.

Roman engineering

The Romans have long been hailed as the greatest of ancient engineers. Their roads and bridges were scattered all over the Ancient World and they built over 200 city water supplies. In fact, it was over a thousand years following the collapse of Rome before the new people of the West again achieved standards of life comparable to those of Roman days. Furthermore, while the art and literature of classical times were temporarily lost to sight with Rome's collapse, the new West was born among the ruins of the Roman engineering works. They remained to challenge and inspire Western man through the Dark and Middle Ages.

The story of Roman engineering offers sharp contrasts to that of Greece. Rome produced no Archimedes who sought to prove by the principles of mathematics and mechanics the hard-gained practical understandings stemming from experience. No Hero of fertile and inventive mind found new applications for even the limited mathematical and scientific knowledge of the day. It may be argued that the scientific approach to engineering was foreign to the Roman mind.

All roads, it was said, led to Rome. Actually they all led from the Eternal City, marking the successive steps by which the Latins of the Tiber Valley gradually extended their control over the Italian peninsula—first phase of their conquest of the Ancient World.

Not only was scientific curiosity lacking but major incentives to increased scientific understanding in engineering were also absent. It was an age of inexpensive and abundant materials—timber and stone; of simple structural forms—walls, beams, col-

umns and arches; and of cheap manpower, usually provided by slaves. We are, in short, dealing with an Age of Timber and Stone, an age in which experience rather than science was the guide.

Nevertheless there seems to have been a clear division between what we would call the purely technical and manual as contrasted with the more professional aspects of engineering practice. Public officials were expected as part of their duties to undertake the planning, direction, and administration of public works, and their reputations rested in large measure on their success in such undertakings. While often impressive in scale and bold in execution, their works were, judged by modern standards, simple in design and involved practical skill in construction rather than high technical competence in planning.

Engraving by Piranesi shows Appian Way with characteristic pavement of polygonal stone blocks, "a wall laid on its side." Of course Via Appia of 312 B.C. was not paved thus throughout its 125-mile length. Only sections in or near towns, and then only as conditions demanded, received this costly type of surfacing.

The Roman mind was intensely practical, cold and calculating, able in organization and inclined toward standardization. The public official, the true professional man, ultimately had at his command numerous technical aides from the *agrimensors* (land surveyors) *librators* (levelers) and *mensors* (quantity measurers) to the *aquilegus* (aqueduct inspector) and the *viarum curator* or superintendent of roads. These technicians undoubtedly based their practices largely on earlier Greek methods. Greek works in Italy and Sicily challenged emulation. The conquests of the Republic brought to Rome as slaves educated people from other lands. Greek slaves, besides introducing the wealthy Romans to the treasures of Greek art and literature, brought in the fundamentals of Greek technology.

As Roman life developed, the Roman *architectus* (a title echoing that of the Greek *architekton*) began to emerge as an intermediate specialist between the public official and the technician and artisan. Yet even in the later empire, such emperors as Trajan and Hadrian were competent to initiate architectural and engineering undertakings and to speak understandingly of the problems involved in their planning and execution.

At first sight this organizational relationship would not appear to have been favorable to technical development. Yet the Roman master builder made notable contributions to the techniques of his profession. He did not invent the arch but he made it a fundamental component of bridges and aqueducts. He provided techniques of construction (foundation work, use of timber piles and concrete) and developed construction machines (treadmill hoists and pile drivers) that were used throughout the long Era of Timber and Stone—that were in fact standard equipment right down to the modern age when iron and steam replaced manpower. The director and planner remained in sufficiently close contact with the actual construction to be able to develop methods and equipment suited to the conditions of the day.

In spite of standardization, experience was an effective teacher, as a comparison of the aqueducts Marcia and Claudia will show, or especially, a comparison of the Pont du Gard and its sister work, the Aqueduct of Segovia, built a century later. Through experience the builders achieved structural insights that permitted notable refinements in design and construction. Indeed it was solely through experience that man's greatest triumph in stone construction, the Gothic cathedral, was made possible in the later Middle Ages. We are apt to forget in this scientifically minded age that science is a newcomer in human affairs and that before its advent man successfully met his needs and constructed some of the most imposing structures the world has ever seen.

The engineer also owes a great debt to Roman law. For example, expropriation, the condemnation of private property for public use, although perhaps not a well formulated administrative procedure, was recognized in the case of aqueducts and other public works, and in many cases provided for by specific legislative action. In mining law the idea of "extra-lateral rights" emerged—the right to follow a vein under another's property.

Rome's greatest material gift was the discovery that the addition of a volcanic ash or earth, pozzuolana, to lime provided a true hydraulic cement which would harden in bulk or under water. Found in quantity near Rome but especially at Pozzuoli near Naples, this ash replaced the Greek Santorin earth, made concrete

Aqueduct Marcia, built in 144 B.C., included some six miles of such massive stone arches carrying high-level water supply to Rome. Later brickwork in arch at left is evidence of difficulties encountered in maintaining such works, which were vulnerable to severe cracking due to temperature changes and foundation settlement. Two later aqueducts were carried "piggy-back" on the arches of this greatest of early Roman stone structures.

(Vol. p. 552)

possible, and remained practically the best, almost the only hydraulic cement available until the early nineteenth century.

Appius Claudius, municipal engineer

The earliest Roman builder whose name and achievements have come down to us is Appius Claudius, active in the early days of Latin Rome. He succeeded in attaching his name to two pioneer Roman works, the Appian Way and the aqueduct Appia. Yet many Roman construction techniques go back to earlier days. As we learn more of the Etruscans it seems probable that they handed on to the Romans the arch and tunneling techniques and perhaps other construction skills.

Frontinus notes that for 441 years after the founding of Rome, water was secured from wells, springs, or from the Tiber. He then relates that, in 312 B.C. "the Appian water was brought into the city by the Censor Appius Claudius Crassus who also had charge of the Appian Way from Porta Capena to the city of Capua (near Naples). He had for his colleague C. Plautius, who received the name Venox (or searcher of springs) on account of his search for the springs of this water; but since Plautius resigned his office of censor before the expiration of the eighteen months (the normal term of office), as a result of the erroneous impression that his colleague would do the same, Appius alone enjoyed the honor of giving the aqueduct its name; and it is said of him that by various contrivances he managed to extend his office as censor until he completed not only the aqueduct but also the highway."

Appius thus appears to have been a rather crafty and high-handed even if competent advocate and planner of public works. He ignored established laws and was opposed by the wealthy nobles, who accused him of exhausting the public treasury (a censor was a tax official) in seeking public acclaim. His aqueduct, Appia, was a low-level, largely underground work in tunnel or cut-and-cover construction. It was the first of a dozen aqueducts ultimately built not only to increase the supply but to bring it in at a higher level so that it would reach fountains and meet other needs on the famous Seven Hills. In 272 B.C., an interval between wars, another aqueduct, Anio Vetus, followed, while in 144 B.C. Marcia, the famous "high-level" supply and the pride of Ancient Rome, was brought into the city.

The modern student frequently gets a wrong idea of Roman road construction. From views of the Appian Way near Rome paved with polygonal stone blocks, one is led to believe that its full 125-mile length was similarly surfaced. Actually the streets of Rome were not extensively paved in this way until a later date and even in 189 B.C. we read of the Appian Way being paved for a short distance near Rome. The paved Roman way was, in fact, prohibitively costly for extensive use. Roman highway traffic was largely by foot and pack animal rather than by wheeled vehicle and the Romans do not appear to have developed a practical road surfacing of a less costly type.

Like the majority of Roman roads, the South Road of Appius made straight for its mark, crossing hill and valley with little attention to topography. The Great North Road of about 220 B.C. carried Roman influence over the encircling crescent of the Apennines into Cis-Alpine Gaul, the valley of the Po in Northern Italy. As in the case of the earlier work, it was named the Flaminian Way after the censor who fathered the project. Soon the entire Italian peninsula was tied together by roads, all of which led to Rome.

The Cloaca, the so-called Great Sewer of Rome, was likewise an accretion rather than a single original undertaking. It did not mark the beginning of a comprehensive sewer system in the modern sense. Beginning as an open drainage ditch following a natural water course in the low-lying area of the Forum, it was walled up and covered over as the city grew. Little or no provision was made for domestic sanitation, and all that can be seen of it today is its outlet in the later embankment walls of the Tiber.

Marcius and the Aqueduct Marcia

The task of bringing a high-level water supply into Rome was made difficult by the comparatively flat Campagna, which surrounds the city's Seven Hills. Lacking pressure pipes, the supply had to be carried "at grade" on supporting arches from nearby mountains. To take advantage of the highest supporting ground and the shortest distance across the Campagna, a long cut-and-cover line had to be built circling the high ground from the River Anio (the principal source) and then across the Campagna on arches to the city. Anio Vetus, 43 miles long, had brought in water at some 90 ft above "Old Appia," but was largely a cut-and-cover job. The new aqueduct Marcia was 195 ft above Tiber level, some 58 miles long, and was carried on stone arches for over 6 miles. Marcia established a route followed by later construction and was long referred to by Roman writers as a milestone of the great days of the Republic. In contrast with the cheaper concrete and brick commonly used in later aqueducts, Marcia was built of stone with a waterway 4½ to 5½ ft wide and 8 to 9 ft high, the largest of all Roman aqueducts.

The Roman Senate had commissioned Marcius, the praetor or legal adviser to the two consuls who headed the state, to restore the two older aqueducts and supervise this new work. Unquestionably legal problems were involved such as securing a right-of-way and, perhaps, the illegal diversion of water from the older supplies which had also developed leaks. As Frontinus later made clear, there were constant problems in the maintenance of Rome's water supply.

Of the engineers involved in this work we have no record. Shortly after 200 B.C. Roman writers (for example, Plautus) mention the "architectural worker." Presumably by the time Marcia was under construction, a half-century later, the *architectus* had emerged as a technical expert. Greek workers were being brought to Italy, and a new era of public building construction developed in the later Republic.

In 127 B.C., only 17 years after Marcia was built, a much smaller aqueduct, Tepula, was built on top of Marcia, while a century later the Aqueduct Julia was placed, piggyback, on top of Tepula. Both these aqueducts were of cheaper brick and concrete construction. In fact, there was a continual bracing up of old arches by exterior brick work, in some cases filling the entire arch openings. As Herschel notes in his study of Frontinus, the variable slopes of the earlier Roman aqueducts reveal the limitations in accuracy of the leveling devices of the day, and perhaps also, careless construction. The need for constant repairs indicates the difficulties caused by expansion and contraction with changes in temperature, and also no doubt by settlement of foundations. With the Claudian Aqueduct of the Early Empire there was a return to massive cut-stone construction, but the same maintenance problems continued throughout Roman times and through many later centuries.

(In a subsequent article Dean Finch will discuss other achievements of the Roman builders of the Republic, including bridges.)

Form that can be quickly adjusted is feature of bed in which five octagon-shaped piles (16 x 16-in.) are cast end to end in each row. Piles are cast and moved on three-day cycle.

PRETENSIONED PILES FOR NAVY PIER

WILLIAM F. REMINGTON, A.M. ASCE

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Pretensioning is being used for more than a thousand precast concrete piles averaging 76 ft in length for the new pier at the Long Beach (Calif.) Naval Station. This pier is 50 × 1,700 ft. The contractor, Ben C. Gerwick, Inc., had the option of using conventional or pretensioned piles and chose the latter.

Piles are cast in a 45 × 378-ft bed that accommodates five piles in each of six rows of forms. Two rows of forms are arranged to be cast together and covered for steam curing on a three-day cycle. The five piles that are laid end to end in a row are tensioned in one operation. Intermediate bulkheads fix the length of the individual piles. After the concrete has reached design strength, the pretensioning steel is burned off to separate the piles.

In the alternate design, the conventional precast piles were to be 18 × 18 in. in cross section, reinforced with four No. 8 bars (0.79 sq in. each in cross section) and four No. 10 bars (1.27 sq in.). A four-point pickup was required for piles 70 ft long and under. A total of 73,730 ft of piling was specified for 1,019 units of this type.

The pretensioned piles are octagon shaped, 16 × 16 in. in cross section, and tensioned by 13 cables of ⅜-in. diameter. The total length required is 76,787 ft—an average of 3 ft more per pile than for the conventional type. This increased footage for the smaller pretensioned piles is required to make their skin friction and bearing capacity equal to those of the 18 × 18-in. piles. The design penetration is 25 ft in sand, but one-third of the piles have deeper penetrations in anticipation of future dredging.

Each pile has a design capacity of 40 tons. For the conventional 18 × 18-in. pile, the section modulus required for a four-point pickup would exceed that necessary for column strength in the pier, whereas for a pile 70 ft long and under, of the pretensioned type, with a two-point pickup, the concrete stresses amount to only 1,372 psi in compression. The allowable load on the pretensioned pile in column action is 191 kips, while that on the alternate conven-

tional pile is 142 kips. The difference of 39 kips is extra capacity (and factor of safety), which the Navy is getting without additional cost.

Other advantages of prestressing

Prestressed concrete is much more durable in salt water than normally reinforced concrete, as C. M. Wakeman, Chief Testing Engineer for the Los Angeles Harbor Department, has shown. Thirty years ago he installed a prestressed specimen alongside of some normal concrete specimens in the tidal zone. The normally reinforced specimens have shown serious spalling and deterioration whereas the prestressed specimen has suffered no deterioration.

Another big advantage to both the owner and the contractor in the use of pretensioned piles is their ability to withstand heavy driving without damage. Tests conducted jointly by the Navy and the Long Beach Harbor Department revealed that a 14 × 14-in. pretensioned pile driven to refusal took 800 blows from a No. 1 Vulcan hammer (single-acting, 5,000-lb ram, 3-ft fall) with no damage. The energy absorption capacity of a pretensioned pile permits quicker and safer driving with less jetting. It also reduces inspection costs.

Although pretensioned piles are relatively new, and more information about their behavior will be accumulated in years to come, some "red lights" in their design and manufacture are already fairly well established. The first of these pertains to steam curing.

Economy calls for rapid curing

Rapid curing of pretensioned piles is imperative to make their production economically competitive with that of conventional piles. Steam curing produces high early strengths and permits early transfer of prestress from the casting bed to the piles. This enables the contractor to remove the piles from the high-cost pretensioning bed for quick reuse of the bed.

Naturally the tendency is to rush the steam curing process at high temperatures to achieve the required strength as quickly as possible. Although good results have been obtained with quicker applications of steam, the writer believes that such application should be delayed until at least three hours after the initial set of the concrete. The steam should be applied slowly and evenly to the entire pile. The specifications limit the temperature for curing of piles for this pier to 150 deg F. Elsewhere higher temperatures have sometimes been used.

The required strength for transfer of prestress to the concrete is 3,500 psi. With steam curing, the beds are ready for reuse every 48 hours. The loss in ultimate strength caused by steam curing is not important as the piles were overdesigned to permit easier handling and driving. However these are factors which the designer of pretensioned piles should consider.

After transfer of prestress to the piles, the exposed ends of the prestressing strands are under zero tension. Yet because of the "plugging effect" of the end of the prestress-relieved strand within the concrete, this tension increases to the design value in a very short distance.

High-strength concrete required

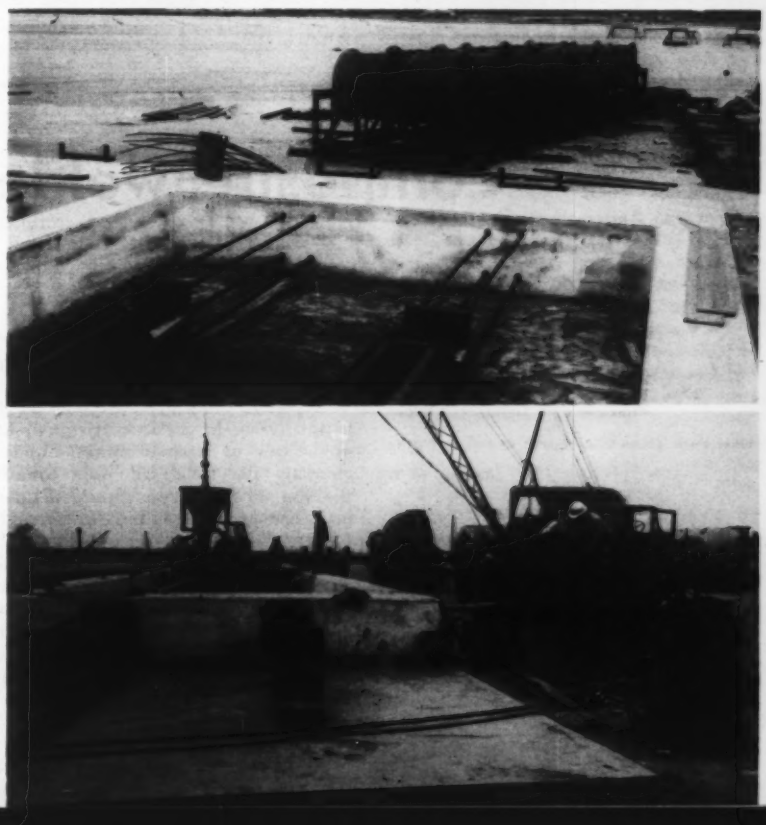
The initial prestress value for *each* strand in the piles is 14,000 lb, a stress that must be integrated radially over a very short distance at each end of the strand. This calls for high-strength concrete and careful stirrup design at the ends of the pile.

After the concrete has cured, this stress is reduced to a safe value by creeping of concrete and steel. A creep of 20 percent was assumed in the design of the new pier piling. Because of the factors mentioned, and to achieve lower bond stresses, the diameter of the prestressing strands was limited to $\frac{3}{8}$ in. The contractor is using Roebling stress-relieved, cold-drawn, high-tension strands with an ultimate strength of 250,000 psi.

The concrete used has a 28-day strength of over 5,000 psi. Not less than 7½ sacks per cu yd of Type II low-alkali cement was specified because of the conditions affecting the local aggregate. Use of calcium chloride as an admixture in prestressed concrete has been found to cause corrosion of the tensioned strands. Use of any admixture except air-entraining agents was prohibited in the specifications for this pier.

To summarize, pretensioned piles offer lower initial cost, increased load capacities, and longer life with reduced maintenance cost. On the other hand, they require carefully designed mixes, limited admixtures, and restricted steam curing.

Thirteen wires of $\frac{3}{8}$-in. diameter are pulled from reels at one end of 378-ft casting bed by hoist at opposite end. Initial prestress of 182,000 lb per pile (14,000 lb per wire) is developed by hydraulic jack on dolly (at left in lower view) through electric powered pump.



Cattaraugus Creek span is typical

Field splicing of girders for Cattaraugus Creek Bridge was avoided by fabrication in Buffalo and delivery to site in one piece. There were 60 girders, each 66 in. deep and 132 ft long. Note spiral shear connectors shop welded to top of girder.

Composite welded bridges for

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The past fifteen years have witnessed a change in the type of highway bridges constructed in New York State. This change—improvement may be a better term—is particularly apparent in the case of superstructures. Fundamentally the trend has been toward the use of deck-type superstructures in place of the outmoded through types.

There are several reasons for this change. The tremendous increase in the number of automotive vehicles on our highways, together with the high speed of travel, demands bridges so designed and so constructed as to incorporate maximum safety at all times under all conditions without any appreciable diminution in the legal rate of travel.

Driving an auto, truck or bus over a through plate girder bridge is not conducive to safe and comfortable driving at a reasonable speed. The driver has a natural tendency to creep towards the center of the highway, away from what appears to be a wall of steel. In addition, the sight distance is drastically reduced, especially if the approach grades are fairly steep and the summit located at the center of the span, as has been the case with

many through structures, some of which are still in use.

In winter, the piles of snow at the sides of through structures may be appropriate to a ski run but have no business in a location where they reduce the effective width of the bridge roadway, obstruct drainage, and increase the chances of accidents.

Through bridges have also been a source of irritation to engineers and laymen alike on the ground of appearance. The change to modern deck superstructures eliminates eyesores and makes for functional beauty as well as increases safety, and last but by no means least, makes for economy in construction, snow removal, and maintenance.

Primarily, the deck-type superstructure furnishes maximum sight distance so that no appreciable sacrifice in speed is necessary for safety. Another important feature is that, should future conditions warrant, the bridge can be widened at minimum cost with no inconvenience to existing traffic.

The modern deck-type highway bridge has a roadway wider than the approach pavement, thus providing space for snow removal without reducing the travel width or obstructing drainage. These additional side widths may be likened to the shoulders of the approach highway; they provide safety areas for maintenance equipment that may be needed on the bridge, as well as temporary parking space for disabled vehicles.

Engineering developments in two different directions enabled the New York State Department of Public Works to utilize steel deck bridges on an economical and efficient basis at practically all locations. One was the improvement in electric arc welding together with the development of electrodes with low-hydrogen coatings, and the manufacture of a structural steel rolled to controlled chemical as well as physical requirements, so as to permit economical welded fabrication of plates of substantial thickness without the need for stress-relief treatment.

The other major development was the extended application of composite design. Composite design, by anchoring the reinforced concrete structural slab to the structural steel, enables these two materials to act together as an effective unit in resisting stress. It also reduces the overall floor depth to an absolute minimum, reduces the vibration caused by moving vehicles on the structure, and has a favorable effect on maintenance costs since the formation of cracks in the concrete due to vibration is materially reduced. A minimum floor depth also means economy in the construction of approaches, since the depth of fill required to obtain standard vertical clearances over waterways, highways, or railroads is reduced.

Pratically all the 500 steel bridges on the New York Thruway are welded. One recently completed bridge has a deck area of about two acres—that carrying the Erie Section of the Thruway over Cattaraugus Creek, 30 miles southwest of Buffalo.

Cattaraugus Creek is about 70 miles long, flows in a westerly direction, and drains an area of about 560 sq miles. Its drainage basin is narrow and, except for the lower five miles, generally hilly and well timbered. Based on Talbot's formula, the area of bridge opening required to pass drainage was ascertained to be 7,300 sq ft. Our final layout, consisting of five 132-ft spans, provides an opening of 7,900 sq ft.

Cattaraugus Creek is a winding stream subject to heavy floods and bank erosion. To improve its alignment and flow, the channel was relocated at the site of the bridge and the new structure was built square with the relocated stream. To protect the approach highway fills and abutments against possible erosion, a 6-ft reinforced concrete wall on steel sheetpiling was constructed around the toe of the fill, and a concrete slab was laid on the slope from this wall up to high-water elevation and back along the fill to the natural ground level.

Studies of the subsurface boring data indicated varying mixtures of sand, clay and gravel of various depths overlying hardpan. It was determined that the cast-in-place concrete piles should be driven to a resistance of 30 tons each. Because of possible differential settlement of the substructure, a continuous superstructure design was not used.

To establish proper clearance above the predictable crest elevation of floods and ice floes and still hold embankment heights to a minimum, shallow welded deck plate girders with composite design offered the most economical arrangement for the superstructure, with five 132-ft simple spans. The design was in accordance with the current specifications of the American Welding Society and the American Association of State Highway Officials for H20-S16 live loading.

Provision was made for three lanes of traffic in each direction with safety walks along the curbs, and with a raised mall 8 ft in width in the center to separate opposing traffic. Each roadway is 49 ft wide, which furnishes 6 ft of additional width on each side of the bridge, beyond that of the approach pavements.

Comparative structural studies indicated that a spacing of 9 ft 4 in. for the deck girders would provide an efficient and economical arrangement. A structural concrete slab 8 in. thick was used, reinforced transversely top and bottom with $\frac{5}{8}$-in. round reinforcing bars and with $\frac{1}{2}$-in. round bars in a longitudinal direction. A cement concrete wearing surface $3\frac{3}{8}$-in. thick, reinforced with wire mesh, was built on the structural slab.

All 60 welded deck girders for the bridge are identical, which made for economical fabrication. The four piers needed for the substructure were also designed to be identical thereby effecting further economy in form work and construction.

To assure positive composite action of the concrete slab and the steel girders, provision must be made for adequate shear connectors between the steel and the concrete. This is to make certain that the horizontal shear developed between the slab and the steel is taken care of and to cause the two materials to deform together. Shear connectors can be made of steel plates, channels, angles, Z-bars, or spiral rods —welded to the top flange of the steel girder and embedded in the concrete slab. These shear connectors tend to act as a lateral support for the top compression flange of the steel girder besides providing lateral bracing for the entire superstructure.

In our original investigation of the various types of shear connectors available, we determined that the so-called Alpha System, which uses a spiral round rod, represented the most efficient type. It is assumed that the

New York State Thruway

spiral transmits the shear into the concrete by bond and by the bearing of the concrete on the projected area of the spiral rod. The spiral acts in a manner similar to the end hook of a reinforcing bar. The action of such a hook is difficult to analyze but it is known to be effective. The spiral appears to be superior to the end hook because each loop is welded to the steel beam and cannot open up under stress. Furthermore, the spiral is not in one plane and the danger of cracks developing longitudinally is small. In addition, the concrete surrounded by the spiral is toughened, since the spiral rod, being in the compression zone, develops action similar to that of spiral reinforced concrete columns. We used $\frac{5}{8}$-in. round bars of 6-in. mean diameter, and the amount of horizontal shear determined the pitch of the spiral, which varied from 6 in. to 16 in.

All the deck girders were built up of 66-in. x $\frac{7}{16}$-in. web plates with single flange plates 24 in. wide top and bottom. The top flange plates vary in thickness from 1 in. to $2\frac{1}{2}$ in., and the bottom flange plate, from 1 in. to $3\frac{1}{2}$ in.

The flange plates were completely welded before assembly with the web. The web plates were also spliced and welded in advance of assembly. The whole girder assembly was made by continuous fillet welds varying in size from $\frac{5}{16}$ to $\frac{1}{2}$ in. depending on flange-plate thickness. To avoid locked-in residual stresses, assembly welding was started at the center of the girders and advanced toward the ends, thus leaving the ends free to move as the welds contracted during cooling.

The contract plans were prepared on the basis that the girders would be completely shop-welded and erected in one unit but provision was made to introduce one field-welded splice for each girder. We were fortunate that the steel contractor for the project, the Ernst Construction Company of Buffalo, very capably fabricated and erected all the girders without using any field splices.

Intermediate stiffeners for the girders consisted of 11 x $\frac{11}{16}$-in. plates, and the end stiffeners were 11 x 1-in. plates. The upper ends of all stiffeners are welded to the compression flange as well as to the web. When the plans for the Cattaraugus Creek Bridge were prepared, in 1946, we were proceeding on a very conservative basis for all-welded girders. As no welding was permitted perpendicular to the direction of tensile stress, the bottoms of the intermediate stiffeners were fillet welded to pads or fillers, which in turn were fillet welded directly to the bottom tensile flange plate by longitudinal fillet welds.

Since the primary function of stiffeners is to stiffen the web plate, present practice is to weld the intermediate stiffeners to the web and compression flange only, and simply rest these stiffeners on the tension flange.

The spacing of intermediate stiffeners for all interior girders was based on AASHO specifications. For the fascia girders, we used welded brackets to support the cantilevered safety walks and railing posts. These brackets also acted as stiffeners for the fascia girders and were so spaced as to achieve a pleasing appearance. For further architectural treatment, the upper ends of the brackets and the concrete face of the safety walks were covered by a steel plate, running the length of the bridge and welded to the brackets.

Each span of this bridge was braced by 5 lines of interior diaphragms and 2 lines of end diaphragms. The interior diaphragms were composed of 3 x 3 x $\frac{3}{8}$-in. angles, top and bottom, with two 5 x 5 x $\frac{3}{8}$-in. diagonal angles, all welded to the stiffeners. The end diaphragms, also welded to the stiffeners, are composed of an 18-in. channel under the top flanges and a 3 x 3 x $\frac{3}{8}$-in. angle over the bottom flanges of the girders. The channels supported the end dams together with the back walls of the abutments.

Much study was given to the choice of railing for this bridge. Of welded steel tubular type, this railing not only protects vehicular and pedestrian traffic, but also adds to the beauty of the structure. After all, the railing is one of the prominent features of any bridge and practically the only part visible to the highway user. This railing, as developed by the New York State Department of Public Works, is not only practical and strong, but also by its horizontal motif harmonizes perfectly with the structural arrangement of the deck-type bridge. Manufacturing, erecting, and maintaining these modern railings requires a minimum of cost.

On the Cattaraugus Creek Bridge, the railing consists of three intermediate horizontal lines of $2\frac{1}{2}$ x $2\frac{1}{2}$ x $\frac{1}{4}$-in. steel tubing, a top horizontal rail of 5 x $2\frac{1}{2}$ x $\frac{3}{16}$-in. steel tubing, and 4 x 4 x $\frac{1}{4}$-in. vertical steel tubular posts.

Each girder span, being of simple design, has an expansion end and a fixed end. The bearings to support the girders were also welded of steel plates. They are of simple but effective design, of rocker type to permit free rotation of girder ends. Over each pier, there is a $1\frac{1}{2}$-in. opening between spans, which is filled with a joint material composed of sponge rubber supported on copper flashing and topped by a calking compound.

At the end of each abutment, a $1\frac{1}{2}$-in. opening is provided between the end of the bridge slab and the approach pavement. This opening is sealed with a premolded bituminous joint material capped by a calking compound.

For those interested in statistics, it may be stated that the Cattaraugus Creek bridge contains:

10,500	bbl of cement
5,700	cu yd of concrete
270	tons of steel bar reinforcement
2,160	tons of structural steel
10	tons of spiral shear connectors
32,750	lin ft of cast-in-place concrete piles

General contractor for this project was Johnson, Drake and Piper, Inc. of New York, N. Y. As stated before, the structural steel was fabricated and erected by the Ernst Construction Corp. of Buffalo, and the pile driving was handled by Horton Pile Driving Co. of Kenmore, N. Y., of which N. H. McLain is president.

Inspection of construction was handled by forces of Wm. H. McFarland, A.M. ASCE, consulting engineer of Binghamton, N. Y. Walter J. O'Brien, of the New York State Department of Public Works, was general supervisor under the direction of Elmer G. Youngmann, head of the Department's District Office in Buffalo, N. Y.

In conclusion, the successful development of all-welded bridges in New York State, together with composite design, must be credited to the foresight and determination of two Members of ASCE, E. W. Wendell and C. F. Blanchard. As Deputy Chief Engineer of the N. Y. State Department of Public Works in Charge of Bridges, Grade Separations and Structures, Mr. Wendell had the courage of his convictions in advancing welded steel bridge construction at a time when many engineering executives in state, federal and railroad service were skeptical of this development. Now retired from state service, he has been succeeded by Mr. Blanchard as Deputy Chief Engineer, under whose direction the development of all-welded highway and railway bridges has steadily advanced.

(This article was originally presented by Mr. Ramer as a paper at the ASCE Buffalo Convention, before the Structural Division session presided over by James N. De Serio, a member of the Division's Committee on Session Programs.)

UNCONVENTIONAL FOUR-LEVEL INTERCHANGE IN GREATER NEW ORLEANS

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Since World War II, there has been a phenomenal growth of vehicular traffic in the Greater New Orleans area, especially on the two interurban routes, Airline Highway (U.S. 61) and Jefferson Highway (U.S. 90). Airline Highway leads to Baton Rouge and beyond, and Jefferson Highway connects with the Huey P. Long Bridge over the Mississippi. The interchange described in this article is at the junction of Airline Highway with Causeway Boulevard—the name given to the Greater New Orleans Expressway between the Lake Pontchartrain Bridge and the Jefferson Highway. This interchange was opened to traffic on June 6, 1957. An integral part of the Causeway Boulevard development, which is however not included in this article, is the grade separation at Jefferson Highway, designated as the "Jefferson Hook." [Location and design of the Lake Pontchartrain Bridge were described in an article by William H. Smith, M. ASCE, in the May 1955 issue of CIVIL ENGINEERING.]

An analysis of traffic was made for the Airline Highway Interchange, based on the State Highway Department's 1953 survey of through traffic and turning movements at intersections of this highway with three nearby cross routes. Statistical data from DeLeuw Cather's analysis for the Lake Pontchartrain Bridge were used, with due allowance for local induced traffic. As a result, 24-hour design traffic volumes for the interchange were deduced for the following movements:

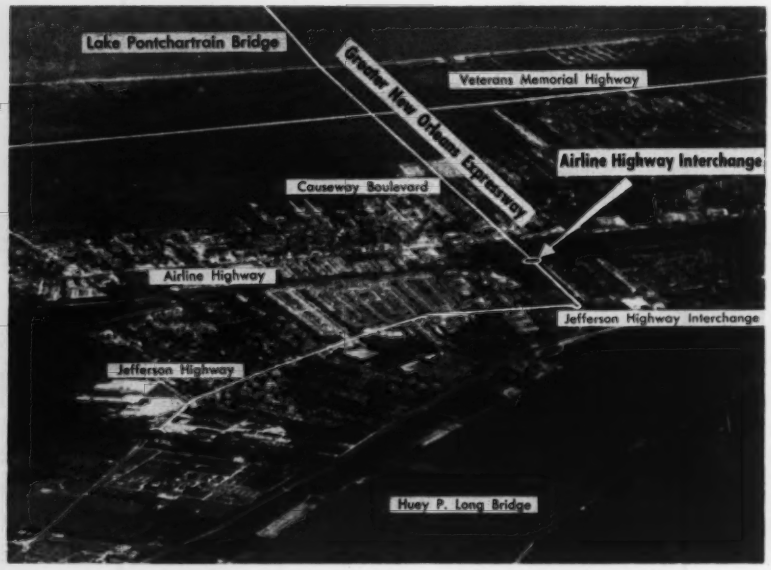
TRAFFIC MOVEMENTS	TRAFFIC (24-HOUR)	
	Maximum	Conservative
Airline Highway through traffic	45,000	.....
Causeway Boulevard through traffic	21,600	.....
Right turns	32,400	23,500
Left turns	43,500	31,500

The analysis indicated conclusively that the interchange should provide for all turning movements at the junction of Causeway Boulevard and Airline Highway.

Studies lead to adopted plan

More than a dozen different arrangements were studied for the interchange, and diverse schematic plans, profiles, and sections were prepared. Out of these studies seven comparative schemes evolved, for which construction cost estimates were made. Balancing traffic demands, functional requirements, economics of structures, and funds available, the adopted scheme consists of the following main features:

1. Separation of eastbound and westbound roadways of the Airline Highway underpass, holding the original alignment.
2. Separation of northbound and southbound roadways of the Causeway Boulevard overpass.
3. Provision of separate two-lane, one-way ramps in all four directions, connecting to an intermediate-level traffic circle, that is, elevated above track level. This type of traffic circle, restricted to turning movements only, does not have the disadvantages of a traffic circle handling both through and turning traffic.
4. Keeping the railroad tracks at existing grades, merely shifting two tracks 13 ft to permit location of bents and use of economical span lengths.
5. Carrying the railroad tracks at their present grade across the Airline Highway underpass on two double-track plate-girder bridge structures of two spans each.



Interchange structures costing over $5½ million have just been completed in New Orleans to handle heavy traffic where Causeway Boulevard intersects Airline Highway. Overpass and unique elevated traffic circle were opened for traffic on June 6, 1957. Note that Greater New Orleans Expressway is called Causeway Boulevard between Lake Pontchartrain Bridge and Jefferson Highway.

6. Provision of service roads at grade in all four quadrants.

Space geometrics

Space geometrics of the interchange can best be described by resolving the structure into four components: (1) the Causeway Boulevard through-traffic overpass (top level), (2) the interchange for turning movements (the circle at intermediate level), (3) the railroad-track crossings and service roads (ground level), and (4) Airline Highway underpass (depressed level).

The profile of the Causeway Boulevard overpass consists of parabolic curves and tangents with maximum up and down grades of 5 percent and a height at the summit of El. 55.40. (All elevations are given in feet above or below Mean Sea Level.)

The intermediate-level interchange has a traffic circle with a diameter of 353 ft at the centerline, and ramp curves varying in radii from 200 to 281 ft. The ramp centerlines are 5 ft 6 in. outside the centerline of the traffic circle at their nearest points. The traffic circle and ramp curves are superelevated in opposite directions at the rate of ⅛ in. per ft. The grade of the traffic circle is approximately level, at El. 34. There are four up-ramps and four down-ramps, each consisting of vertical curves and tangents with maximum ascending grades of 6 percent and maximum descending grades of 7 percent.

At ground level, the centerlines of the four railroad tracks of the Southern Railway and the New Orleans Terminal Company, a subsidiary of the former, intersect the centerline of the Airline Highway at an acute skew angle of 35° 04′.

Airline Highway is to be depressed under the railroad structures to provide a minimum vertical clearance of 15 ft with maximum up and down grades of 5 percent.

All quadrants of the intersection are geometrically different, requiring different radii for the curves of the connecting ramps at the intermediate level. Moreover, the location of bents is complicated by the skew intersection of the railroad tracks with Airline Highway. It was within these geometrical and physical limitations that proper bent locations and economical span lengths had to be sought.

This work required the transformation of geometric properties into structural dimensions and elevations, and involved tedious and lengthy computations with a high degree of precision. But once the general procedure had been set up, speed of calculation and the required accuracy were achieved through the combined use of computing machines and 8-place trigonometric tables.

The Causeway Boulevard overpass at Airline Highway consists of two roadways, each having a width of 28 ft, with a median divider 4 ft wide. The normal width of traffic-circle roadways is 33 ft, and that of ramp roadways, 22 ft. Where the ramps merge with the overpass structure, the maximum curb-to-curb dimension over one bent is 116 ft. A safety curb 1 ft 6 in. wide is provided inside the railing. The Airline Highway under-

In early stage of construction, bents stand at various angles, waiting for superstructures to be erected.

pass will provide two 40-ft roadways with a 16-ft median divider, curbs 10 in. high, and higher protecting curbs around the bent columns located in the median divider.

Structural features

All roadways are designed for AASHO H-20-S16-44 live loading. Roadway slabs have a minimum thickness of 6 in. A special feature is the provision of precast concrete gutters below the outside safety curbs except where the longitudinal slopes are steep. A section of 8-in. transite pipe and a flexible connector on one side of the joint forms the connection at bridge expansion joints.

All wide-flange stringers are of low-alloy structural steel without cover plates, and all members other than main stringers are of structural carbon steel. Normally, there are 4 stringers in each ramp span, 10 stringers in each overpass span, and 6 stringers in the segmental spans for the traffic circle. Where the ramps merge with the overpass, adjacent spans have as many as 18 stringers side by side. Stringer spans vary from 35 to 75 ft. There are 66 overpass spans, 55 ramp spans, and 20 traffic-circle segmental spans.

Superstructures are carried by reinforced-concrete rigid-frame bents. Because of their narrow width, ramps are supported by "hammerhead" bents to minimize ground obstructions and to achieve the economy afforded by balanced dead loads over the cantilever arms. However, two-legged bents are used for the higher ramps, with deeper foundations supporting longer skew spans over the railroad tracks. The overpass is normally supported by two-legged bents. Near the summit of the overpass, where the height is excessive, an intermediate horizontal member 4 ft deep is introduced in the overpass bents. Near ground level, where the ramps and the overpass are carried by the same bents, low three-legged and four-legged bents are used as required by roadway widths. At locations where the ramps join the traffic circle, physical conditions require the use of seven three-legged bents of unequal span in four quadrants, and a five-legged bent of unequal span to avoid crowding of columns and foundations and to clear the railroad tracks.

Cylindrical columns are used throughout. Their diameter is 4 ft 6 in. for "hammerhead" ramp bents; 3 ft 6 in. (spaced 26 ft 6 in. apart) for typical traffic-circle bents; 4 ft 0 in. and 3 ft 6 in. respectively for the higher and lower typical bents of the overpass; and 3 ft 0 in. for four-legged and three-legged bents (with legs spaced as required). Top girders vary in depth as required.

All cantilever arms of top girders taper in width as well as in depth as bending moment decreases. Reinforced-concrete cantilever abutments are used throughout.

Railroad bridges

Two parallel through plate-girder railroad bridges, each accommodating two tracks, will carry the Southern Railway and New Orleans Terminal Company's rail traffic over the Airline Highway underpass. Because this intersection is at a bad skew, each bridge structure has two spans of 95 ft 0 in., center to center of bearings, to cross the two 40-ft roadways and the 16-ft median divider of the Airline Highway. These railroad bridges are designed for Cooper's E-65 wheel loads plus diesel impact, with an additional provision for locomotive nosing—which would occur only if steam motive power should again come into use.

To reduce the length and the grades of the Airline Highway underpass to a minimum, the bridge floor system has been kept to a minimum depth by using wide-flanged cross beams spaced 2 ft 0 in. on centers. A solid ballasted floor on 1½-in. asphalt plank, three-ply bituminous membrane waterproofing, and ½-in. corrosion-resisting steel plate, make the railroad bridge deck of high riding quality and absolutely drip proof.

Since recent performance records have shown high-strength-bolt connections to be more efficient than riveted connections in keeping joints tight under repeated dynamic loadings, the design permits the use of either rivets of ⅞-in. diameter or high-strength bolts for all shop and field connections. Despite the bad skew previously mentioned, all skew connections have been avoided in the design, making both fabrication and erection much easier as well as reducing localized stresses to a minimum.

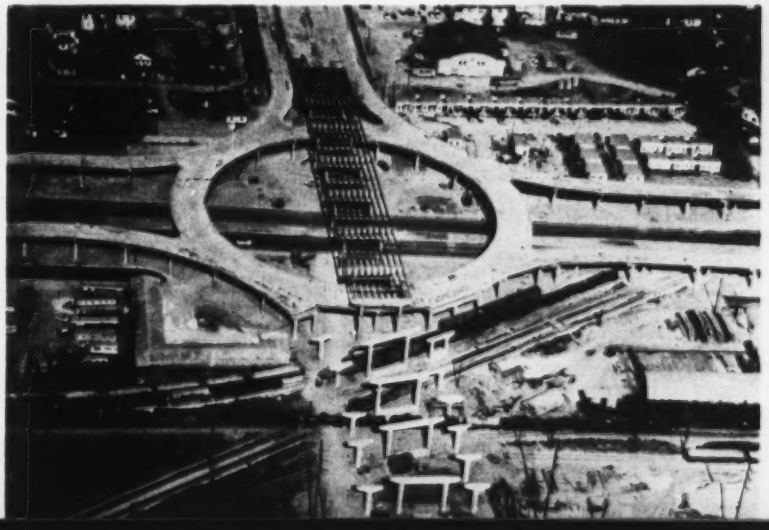
Center piers and cantilever abutments are conventional, but foundation construction requires unusual engineering provisions as will be described.

Underpass and nearby foundations

The financing program required the construction to be carried out in two stages, with the overpass and interchange structures as the first stage and the railroad bridges and underpass as the second stage. This schedule makes it necessary to provide deeper foundations for nearby bents and those located on the centerline of the median divider of the underpass, and also to make special provisions for the construction of the retaining walls of the underpass and the abutments of the railroad bridges.

Near each end of the underpass, where the excavation is shallow, the depressed roadway will be excavated on a natural slope. At intermediate depths, nearby footings will be protected on the inside by temporary sheetpiling to prevent earth movement. In the vicinity of the railroad bridges, where the underpass reaches its maximum depth, two rows of tem-

Bents close to railroad presented special problem as construction had to be coordinated with rail relocation and operation.



porary sheetpiling will protect the ramp-bent footings. The inner row will protect the footings and the outer row will have the additional function of relieving live-load surcharge from adjacent detour roads carrying the Airline Highway traffic during construction. A cutoff wall of steel sheetpiling will be provided under each footing of the retaining walls, driven to a 15-ft depth below the bottom of the footings in the central 560-ft section of the underpass to relieve hydrostatic uplift pressure under the roadway slab.

Constricted space due to the presence of ramp footings near the railroad-bridge abutments limited the heel width of the abutment footings. Therefore, to achieve the desired factor of safety against overturning, the toe of these footings will be extended a short distance beneath the roadway. To relieve the bearing piles under the retaining walls and abutments from bending thrust produced by backfill adjacent to the underpass, a reinforced concrete slab of 15-in. maximum thickness was placed under the roadway. This heavy continuous slab, extending from footing toe to footing toe, was designed to resist the horizontal thrust from the retaining walls, making the roadway slab a continuous strut of the retaining walls or, so to speak, converting the underpass trough into a self-sustaining U-shaped structure.

Underpass drainage

Drainage must be provided for both surface runoff and ground water. At this site, the ground surface is from 4 to 6 ft above MSL, and the water table varies from El. −3 to El. + 3. The underpass stretches 1,625 ft from grade point to grade point and has a width of 106 ft at the inside top of the retaining walls. Drop inlets and special inlets collect water from roadways, from behind retaining walls, from beneath roadways, and from railroad bridge decks, and feed this water into a gravity pipe system, and thence through a 42-in. heavy cast-iron culvert to the pumphouse on the south side, near the railroad bridge crossing.

In the reinforced-concrete pumphouse, which has an outside diameter of 23 ft and an overall height of 51 ft 4 in., there will be three 5,000-gpm pumps, two 1,000-gpm pumps, and one 500-gpm pump. The collected water will be pumped through a 24-in. pressure discharge line to an existing 30-in. drain.

Piles support foundations

As many as 48 test borings were made in and near the site, 16 of them to a depth of nearly 100 ft below MSL. At 60 to 90 ft below MSL, stiff Pleistocene clays and sands were encountered.

Fifteen pile loading tests along Causeway Boulevard, near its intersections with Airline Highway and Jefferson Highway, afforded a good picture of pile performance. Gross settlements were generally less than ⅛ in. and ¼ in. under loads of 70 and 100 tons respectively, and the residual settlements after removal of load averaged less than 1/16 in., and in no case were greater than 7/16 in. Raymond step-taper piles, mainly of 8-in. tip diameter and 14-in. butt diameter were driven, with a 1-S hammer of 19,500-ft-lb striking energy, down to penetrations of 77 to 94 ft.

Piles used for the interchange substructure are of step-taper, cast-in-place type, of 14-in. diameter, designed to support 35 tons each with a penetration down to El. −90. A design and construction problem arose because of the fact that the underpass and railroad bridges are to be built as the second stage of the project. The shells for the cast-in-place piles are driven with a mandrel, and there will not be sufficient headroom for this type of driving under the completed overhead structures. Therefore the 109 piles to be driven during the second stage will be 10 BP 42 steel bearing piles instead of the cast-in-place piles originally planned. The sections used between splices will be as long as possible while still providing the necessary driving clearance.

Altogether, 3,711 piles are to be driven for this interchange, including the overpass and underpass and the railroad bridges. They are in groups of 4 to 12, of 14 and of 22 to support the reinforced concrete footings. The footings are 3 ft 0 in. to 3 ft 6 in. deep, and are square, rectangular, or elongated with eight sides to suit different requirements. The latter type of footing is used under the legs of bents carrying ramp spans on a large skew angle.

Construction problems solved

Work began on December 1, 1955, with the driving and loading of the first test pile. Subsurface conditions were found to be uniform, indicating the adequacy of using 84-ft piles of 14-in. butt diameter, except for one section consisting of three bents where 96-ft piles were required. All the test piles were driven where they would serve as permanent support for footings at the conclusion of loading tests.

The entire right-of-way was not available to the contractor at the time the work started, and the pile subcontractor experienced some delay as work progressed into new areas, since existing buildings had to be removed from almost every parcel acquired.

Plans required the relocation of a track of the New Orleans Terminal Company and the construction of a bent between the four operating tracks after the relocation. To outline procedures for accomplishing this exacting task, a conference was held on the site with representatives of the several railroads involved, the contractor, representatives of the Louisiana Department of Highways, and the consulting engineers. A flexible schedule of construction and train operation was developed by the contractor and the railroads so that the work could be coordinated and rail service maintained on at least two tracks at all times.

Work progressed in the following manner. The contractor worked double shift on two bents immediately west of the railroad tracks. After these bents were capped and the cofferdams removed, the New Orleans Terminal Company placed fill for track relocation and laid the new rails. The contractor then began work on the middle bents, between the two inside tracks, while trains were routed over the two outside tracks. When this operation was completed, the trains used the two west tracks while the east bents were being constructed.

Sheetpile cofferdams were required for the construction of all bents since the footings were placed about 25 ft below the top of rail to allow for the future construction of the underpass between the two ramps. At this depth the soil became fluid during pile driving, making undercutting and backfilling with shells necessary to secure an artificial bottom for the footings.

Another difficulty was caused by an 18-in. high-pressure water line that meandered along the right-of-way. Since this was a main feeder for a large residential section, it was necessary to install a new main outside the construction area for a length of about 2,100 ft. This work was done concurrently with the regular construction, requiring the contractor to defer work on some of the footings until the new main could be put in service. Where the new main had to be laid deeper than 3 ft to avoid conflict with storm drains that were to be placed in a later operation, a large part of the trench had to be sheeted to permit the installation. Such groundwater and soil conditions are of course characteristic of the New Orleans area.

The major problem was that of coordination. The work on the first stage was let in four major contracts with three contracting firms: Louisiana Paving Company on two contracts, Ameri-

can Bridge Division on one contract, and the Keller Construction Corporation on one. Work orders were issued as right-of-way was secured or, in the case of the American Bridge Division, as substructures were completed and ready for steel erection.

All the contractors, subcontractors, railroad companies, right-of-way agents, and others involved maintained a fine esprit de corps throughout the entire period of construction in spite of unforeseen difficulties in meeting predetermined schedules for overlapping construction. The several contracts were brought to completion within a period of one week, thus permitting the opening of all sections of the interchange circle and overpass without delay.

Invitations for bids for the second stage of the work—the Airline Highway underpass and railroad bridges—will be issued in the very near future.

Construction contracts

All contracts were awarded on a unit-price basis. The contract for the Causeway Boulevard overpass and its interchange with Airline Highway, north of the south right-of-way line of Airline Highway, including steel superstructures, was awarded first, on November 20, 1955, to the Louisiana Paving Company, Inc., of Ruston, La., at an estimated bid of $2,930,436.34. The superstructures for the overpass and two ramps south of the south right-of-way line of Airline Highway was awarded on March 21, 1956, to the American Bridge Division of U. S. Steel Corporation at an estimated bid of $844,340.00. Other construction work for the overpass and two ramps, and the Causeway Boulevard extension at grade, south of the south right-of-way line of Airline Highway, was awarded on November 20, 1955, to the Louisiana Paving Company, Inc., at an estimated bid of $1,466,163.17. Including additions agreed upon later, the work here described that has already been completed will cost over $5½ million, pending adjustments for final quantities.

Traffic counts taken by engineers of Palmer and Baker since the new facility was opened show that it has already induced additional traffic on Causeway Boulevard amounting to about 1,700 vehicles per day.

Acknowledgments

That part of the project south of the south right-of-way line of Airline Highway, the Airline Highway underpass, and the railroad bridges are under the jurisdiction of the Louisiana State Department of Highways, of which Ernest J. James, M. ASCE, is Chief Engineer; T. A. Buie, A.M. ASCE, Urban Engineer; A. D. Jackson, Road Design Engineer; and J. B. Carter, Bridge Design Engineer.

That part of the project north of the south right-of-way line of Airline Highway, except the underpass and railroad bridges, is being administered for the parishes by a commission of five members, with the Hon. John J. Holtgreve as chairman.

All engineering services on the project, including supervision of construction, have been rendered by Palmer and Baker, Inc., consulting engineers of Mobile, Ala., and New Orleans, La. Wayne F. Palmer, M. ASCE, President, and Rear Adm. William H. Smith, M. ASCE, (CEC) USN (Ret'd), Vice President and Chief Engineer, have had general direction of engineering work. Kenneth C. Roberts, M. ASCE, Assistant Chief Engineer for Design, was in general charge of plans and specifications. Rear Adm. L. N. Moeller, M. ASCE, (CEC) USN (Ret'd), Assistant Chief Engineer for Construction, has been in general charge of construction, with G. H. Manning as Resident Engineer supervising all construction operations.

W. L. Gasaway, Project Manager of the Louisiana Paving Company, Inc., was in overall charge of the contracts on the overpass, the interchange traffic circle and ramps, and the Causeway Boulevard extension up to Jefferson Hook. Edward Windom, Superintendent for the American Bridge Division, was in charge of erection of steel superstructures.

Reinforced-concrete bents support superstructure of interchange circle. Columns rest on footings supported by 90-ft cast-in-place concrete piles. Roadway slabs were poured on wide-flange beams.

Ultimate-strength design of reinforced concrete slabs

C. W. GRIFFIN, J.M. ASCE, Structural Engineer, Allabach and Rennis, Inc., Consulting Engineers, Philadelphia, Pa.

The new ultimate-strength design method permitted by ACI 318-56, Sect. 601 (*b*) is basically a simpler, more consistent theory of design than the elastic theory. However, at present it is a more time-consuming procedure not only because of its novelty and its varying load factors, but also because of the lack of simple design charts and formulas comparable to those developed for the working-stress method throughout its years of use.

The only chart for designing flexural members in the ASCE-ACI Joint Committee Report, Fig. 5, is not usable for the range of tensile reinforcement permitted in slab design. The lowest value of steel ratio for intermediate-grade steel with a yield-point stress of 40 kips per sq in. is $p = 0.005$.

Chart 1 of the "Guide for Ultimate Strength Design for Reinforced Concrete," by C. S. Whitney and Edward Cohen (*ACI Journal*, November 1956), can be used for the full range of rectangular sections reinforced for tension only. However, this chart requires the computation of M_u/bd^2 and of A_s from $p\ (= A_s/bd)$. Since the concrete strength and the yield point of the reinforcing steel on a particular job almost always remain constant, it is useful to have separate charts for different values of these variables, giving direct values of A_s as a function of M_u.

A simple graph for ultimate-strength design of reinforced concrete slabs is given in Fig. 1. This graph is based on the rectangular stress block also shown in the figure — at lower right. Derivation of the general formula employs the following notation:

- A_s = tensile reinforcement area, sq in.
- f_y = yield-point stress of tensile reinforcement, kips per sq in.
- f_c' = 28-day ultimate strength of concrete test cylinders, kips per sq in.
- a = height of compressive stress block, in.
- b = width of compressive stress block, in.
- M_u = ultimate resisting moment of slab, in.-kips (plotted as ft-kips)
- d = effective depth of slab, in.

By $\Sigma H = 0$, $A_s f_y = 0.85 f_c' ab$

$$a = \frac{A_s f_y}{0.85 f_c' b} \quad \ldots\ldots (1)$$

By $\Sigma M = 0$, $M_u = A_s f_y \left(d - \frac{a}{2}\right)$

$$a = 2\left(d - \frac{M_u}{A_s f_y}\right) \quad \ldots\ldots (2)$$

Equating the values of a in Eqs. 1 and 2 results in the quadratic equation,

$$f_y^2 A_s^2 - 1.7 f_c' bd A_s f_y + 1.7 f_c' b M_u = 0 \quad \ldots\ldots (3)$$

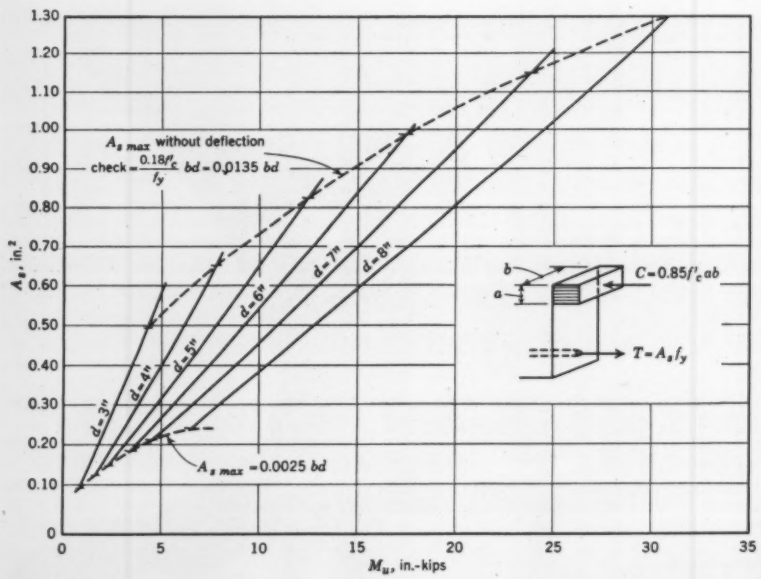


FIG. 1. Graph for ultimate-strength design of reinforced-concrete slabs is plotted for common case where $f_y = 40$, $f_c' = 3$, and $b = 12$.

Solving for A_s yields,

$$A_s = \frac{1.7 f_c' bd - \sqrt{(1.7 f_c' bd)^2 - 6.8 f_c' b M_u}}{2 f_y} \quad \ldots (4)$$

Substituting values for f_y, f_c', b, and d makes A_s a function of M_u, which in the ordinary range of slab design is almost linear. The graph of Fig. 1 is plotted for the common case of $f_y = 40$ kips per sq in., $f_c' = 3$ kips per sq in., setting $b = 12$ in. as the slab width. The limiting value of $A_s = 0.0025\ bd$ is plotted, and also the upper limit of A_s permitted without a deflection check. For the given case, the maximum value of A_s without deflection check is as follows:

$$A_{s\ max.} = \frac{0.18 f_c'}{f_y} bd = \frac{0.18 \times 3}{40} bd = 0.0135\ bd$$

One-way slab solved by graph

An example will illustrate the use of the nomograph. Given a 6-in. slab with a clear span of 15 ft 0 in., where $f_c' = 3$ kips per sq in., and $f_y = 40$ kips per sq in. With a live load of 100 psf and a dead load of 75 psf, total load equals 175 psf.

$$\text{Load factor} = 2.4\ L + 1.2\ B = 2.4\ (100/175) + 1.2\ (75/175) = 1.86$$

For a typical interior bay, design moments are worked out as follows:

	End	Center
	$-\frac{wl^2}{11}$	$+\frac{wl^2}{16}$
	− 3.6 ft-kips	+ 2.5 ft-kips
$M_u =$	− 6.7 ft-kips	+ 4.6 ft-kips
From the chart:		
$A_s =$	0.43 sq in.	= 0.29 sq in.

The corresponding reinforcing consists of No. 5 bars on 8-in. centers at the top, and No. 4 bars on 8-in centers at the bottom.

THE READERS WRITE

Do engineers take themselves too seriously?

To the Editor: I read with interest President Lockwood's address to the Student Chapter Luncheon on "Illusions of Leisure," as abstracted in the May issue. His theme seems to be that something is wrong with young engineers today because they lack the ambition to use their leisure time constructively to build more of the material things which make us fat, lazy, blasé, and sophisticated.

He bemoans the fact that the incentive to work previously given by dangling the carrot in front of the hungry mule is not working so well any more. He states that man (as everyone knows) did not discover he had a soul until he had a full belly. He may mean that man did not have the time or energy to appreciate the beauty around him, or to create it when he was beset by material hardships. A man's soul is a different thing.

President Lockwood seems obsessed with the engineer's habit of trying to make everything in the world useful and efficient—in this case the young engineer himself. He would have us all bursting with ambition as a matter of patriotic duty, even in our leisure time. We engineers might become better men if we did not continually nip off at the bud anything smacking of inefficiency. We are such pragmatists we are unable to see value in anything that gives no tangible results.

Yes, I agree with President Lockwood. Let's enrich our leisure time. But instead of learning how to dictate letters, we might first be sure we have something to say by learning the value of "idle" conversation, of good movies, of good TV programs. Let's not put entertainment into the limbo of "wasted time." By learning something of the art of leisure we might learn how to laugh.

Why can't we turn off the machine and learn not to take ourselves so seriously—at least while we are away from the office?

Louis A. Volse, A.M. ASCE
ASCE Student Chapter Adviser
Asst. Prof. of Eng.,
San Diego State College
San Diego, Calif.

Paid like a clerk

To the Editor: In his article in the May issue, "Illusions of Leisure," President Lockwood advises us to work hard.

As a youth in the tropics, I remember a huge tree by our house under which the dogs used to fight over the honey which dripped from a colony of bees in one of the highest branches. These bees labored long and hard, instinctively producing honey they never tasted. President Lockwood urges us to work hard improving ourselves so we can build up with great economy the properties of others for the production of wealth which we never savor.

It would seem more reasonable to spend a bit more time studying the reasons for our financial plight rather than to go on blindly increasing our efficiency in building. The country is short of engineers because young men are intelligent enough to find out early that the engineer is esteemed little more than a tradesman and paid like a clerk.

If we love our country we will study more economics and organization—and less engineering. A few young men will enter the profession for love of it; a few can be tricked in; but only good pay and social standing will bring every possible mind into the only activity powerful enough to keep the Russians off our soil.

Francis G. Yates, A.M. ASCE
Structural Engineer,
Skidmore, Owings & Merrill
Colorado Springs, Colo.

Avoiding "social boredom"

To the Editors: I read with keen interest President Lockwood's address, "Illusions of Leisure," as printed in the May issue. It is timely and deserves to reach far more readers than can be reached through this publication.

Much has been written on this subject. Professor Russell Kirk of Michigan State University has written a book entitled *A Program for Conservatives,* which every engineer could well afford to have in his library. I quote below from page 133, in his chapter on "The Problem of Social Boredom":

"To understand fully the value of leisure, and the necessity to society of leisured men, we need to apprehend clearly the meaning of 'work.' We must

find our happiness in work, or not at all, Irving Babbitt told America a generation ago. But the work of which Babbitt writes does not exclude leisure: it is not *total* work. And the highest kind of leisure is at the same time the highest kind of work: that strenuous contemplation which demands the utmost in human powers. Aristotle declares that the end of man is an action; the most truly human action, however, is thought. Cardinal Newman remarks that 'life is for action'; and what he has in mind is the action of reason and intellect. The man of liberal learning, then, the man who most deserves leisure, is the man who in actuality performs the highest kind of work. In our time this hierarchy of work, this ethical and intellectual working, is endangered by a sullen equalitarianism which would deprive the philosopher, the poet, and the natural aristocrat of that leisure by virtue of which they are enabled to perform their own special labors."

The above parallels the thinking of Mr. Lockwood—who I think has handled this subject exceedingly well.

J. K. GANNETT, M. ASCE

Cleveland, Ohio

Another pile bearing formula proposed

TO THE EDITOR: These comments refer to the formula for predicting pile bearing capacity proposed by Marvin Gates, J.M. ASCE, in the March issue, p. 65. He claims that his empirical formula "will yield more consistently accurate determinations of bearing power than even the most complex 'complete' rational type."

It may well be that the proposed formula, as compared with many commonly used formulas, does represent a better general fit with load test results. This fact however does not preclude the possibility of finding a new, or employing in a better way an existing, rational type of formula which will be more reliable than the empirical one proposed. For instance, in the Hiley formula, the evaluation of the all-important "coefficient of efficiency" is open to much improvement.

In the formulation of any complex empirical relationship, the choice of variables is the most important point, and it is here that a good basic theory is so helpful. The variables chosen by Mr. Gates, namely, the net hammer energy and the permanent set per blow, are not necessarily the most suitable in number or kind. Another desirable feature is dimensional homogeneity, which is lacking in Mr. Gates' formula.

In a paper prepared for the 1951 Paris (France) pile foundation conference, Dr. N. Janbu, of the Norwegian Geotechnical Institute, presented an energy analysis of drop-hammer pile driving employing a set of dimensionless parameters. The coefficients of energy loss contained in the analysis were related to a large number of corresponding driving and load-test data, and empirical expression was obtained for the overall loss coefficient, k_u, in terms of the dimensionless ratios $W\,H\,L/a\,E\,\delta^2$ and W_p/W, where

W = weight of hammer
H = vertical drop of hammer
L = length of pile
a = average cross sectional area of pile
E = modulus of elasticity of pile
δ = permanent set per blow (aver. of last few blows)
W_p = weight of pile

all expressed in any consistent set of units. The relationship is given in Fig. 1, by means of which the ultimate pile load, Q_u, is calculated using the simple formula $Q_u = W\,H/k_u\delta$.

The above method has been proved to approach very closely the ideal sought by Mr. Gates, providing a formula which gives a maximum deviation of ±20 percent for a great percentage of the cases compiled. Dr. Janbu's article (in French) is contained in Publication No. 3 of the institute mentioned above, whose address is Blindern, Oslo, Norway.

No pile driving formula should be advocated without a warning of the limitations involved. The use of any dynamic formula in the case of cohesive ground should be particularly discouraged, since piles react in an entirely different way during driving than after reconsolidation of the disturbed soil.

ROLF C. VOLD, A.M. ASCE
Soils Engineer
John Mowlem & Co. Ltd.
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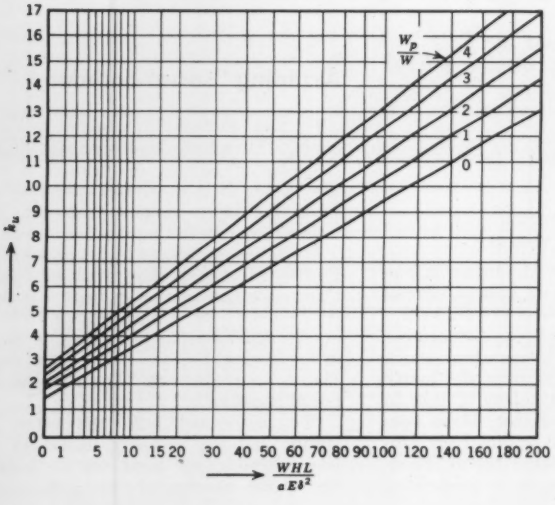


FIG. 1. Coefficient of energy loss, k_u, is plotted as function of two dimensionless parameters. After N. Janbu.

Origin of Junior Forums

TO THE EDITOR: On page 80 of the May issue, a photograph and accompanying note stirred my memories. It stated that "the idea of Junior Forums is thought to have originated with the Los Angeles Section."

The item also stated that the first meeting of the Los Angeles Section was held on March 12, 1930. As the president of the Section in 1930, I can certainly verify both statements. The idea *did* originate here, and I very clearly recall that Harry W. Dennis, then Director from our District, broached the subject in a general way to me early in 1930 and asked me to follow it up with the then Juniors, which I gladly did.

ARCHER F. BARNARD, M. ASCE

South Pasadena, Calif.

Specifications as vital to a job as the plans

TO THE EDITOR: Like many in the construction field, the writer deplores the fact that many engineers and architects appear to pay little attention to the specifications. They may be carelessly prepared by persons not skilled in the construction described or in the art of writing. Frequently specifications are not carefully read by principals of a firm before they are sent out to govern an important construction job.

As a consequence, a skillfully prepared and well drawn set of plans may be messed up by weak and indefinite specifications. Well written specifications are just as vital to a job as the plans.

No specification, no matter how well written, is better than the compliance enforced. Field men and all top personnel of the organization must have the "guts" to enforce the idea and spirit of the specifications to assure that the client gets what he pays for.

STUART S. NEFF, M. ASCE

Niagara Falls, N. Y.

SOCIETY NEWS

Annual Convention Program in New York Highlighted

Professional progress in all its broad ramifications will be the objective of the Society's 1957 Annual Convention, which returns to New York this October after the out-of-town 1956 Annual Convention. Once again the Statler Hotel will be Convention headquarters, and this year's dates are October 14-18. The Convention Committee, headed by Barclay G. Johnson, reminds members that New York weather is likely to be at its zestful best in October.

Diverse Technical Program

Almost all the fourteen ASCE Technical Divisions are at work on their programs for the Convention, which will feature over forty Division sessions. The Power Division is readying a Symposium on Civil Engineering Aspects of Thermal Plants that will reveal much interesting and provocative material. The Waterways and Harbors Division, together with Princeton University and the Port of New York Authority, is sponsoring an all-day Conference on Waterways and Harbors at Princeton University on October 18, the last day of the Convention.

The full technical and social program will be printed in the September issue.

Commercial Exhibit

For the first time at an ASCE Convention, engineers will have an opportunity to see products of advertisers in CIVIL ENGINEERING displayed. Several photogrammetric and survey outfits will show equipment and products. Specialists in concrete forms, foundations, water handling and the like, plan interesting presentations.

The limited exhibition area was offered first to CIVIL ENGINEERING advertisers, who immediately took all 45 spaces available. Exhibits will supplement their regular advertising message to the several thousand engineers expected at the Convention.

Committee on Conditions of Practice

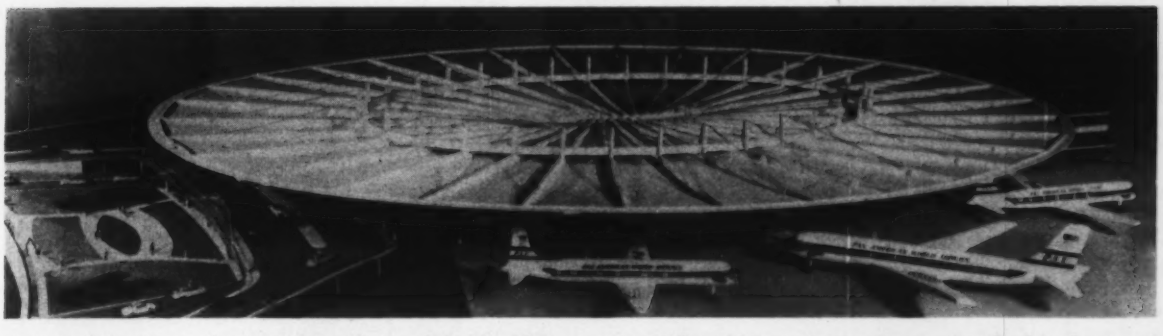
Several timely subjects are up for discussion in the Conditions of Practice sessions program. One session will be devoted to a Study of Economic Advancement Objectives, another to Engineering Education. Joseph W. Barker, president of EJC and chairman of the Board of the Research Corporation, will be featured luncheon speaker.

On the Tour Agenda

The Divisions, in cooperation with other groups, are scheduling a number of tours. These include an excursion on Friday to Idlewild Airport, where the varied facilities under construction rank the terminal with the world's important airports. The Idlewild tour will be conducted by the Port of New York Authority. On Thursday the Power Division will sponsor a trip to the New Jersey Public Service Company's Linden Plant. There will also be a Highway Division tour of recently completed road and street sections in the Metropolitan area as well as highway projects under construction. These include the New York State Thruway and Tappan Zee Bridge; the Lincoln Tunnel Third Tube and Major Deegan Expressway; the Hudson County Extension of the New Jersey Turnpike; and the Garden State Parkway Extension to the New York State Thruway.

Student Activities

"Opportunities Upon Graduation" will be the general topic for the Metropolitan Student Conference, to be held on



Typical of the ultramodern structures designed for the Idlewild construction is Pan American World Airways $8,000,000 terminal building, shown here by a model. The cantilever roof, which will be four acres in area, is especially designed to provide maximum passenger protection. Oval in shape and supported by 32 piers, it is concave upwards to give clearance for aircraft tails. It will be designed to withstand winds of hurricane force.

Wednesday, October 16. During this session the viewpoints of the large corporation, public employment, and small business will be discussed. There will also be a guided student tour of the various Metropolitan engineering colleges.

Pleasant Social Program

Considerable thought is being devoted to the social program, which promises to appeal to all tastes. To get things off to a good start, the Metropolitan Section will be host to a "Kick-Off Party," Monday evening, October 14, from 5:30 to 7:30. Stanley Melba will provide the dance music.

Other highlights of the social program include the Awards Luncheon on Wednesday, October 16, when honorary memberships, the Society's highest honor, will be presented to four members; the dinner-dance and President's reception Wednesday evening; and a smoker Thursday evening. Luncheons and dinners are also being planned by the Divisions, alumni organizations, and other groups.

Wives, of course, are encouraged to attend. The Women's Entertainment Committee, headed by Mrs. Barclay G. Johnson, has scheduled trips, teas, shows—so many interesting events, in fact, that we are going to have to print a special program just for women. On their agenda are trips to Princeton University in nearby New Jersey, and the Governor's Mansion and Fraunces Tavern in New York City.

Employment Restriction Withdrawn by BPR

Under date of July 3 Federal Highway Administrator Bertram D. Tallamy directed a circular memorandum to division and district engineers of the Bureau of Public Roads, which withdraws the anti-pirating feature of the BPR memorandum of December 28, 1956, reproduced in full in the March issue (page 94).

Many individual members of ASCE, some Local Sections, the Committee on Professional Practice, and the Board of Direction have voiced complete opposition to the broad prohibition that a consultant who has a contract with a state highway department may not engage "any professional or technical personnel who are or have been at any time during the period of the contract in the employ of the Bureau of Public Roads or the highway organization of any state, county or city. . . ." The Board, however, considers it "highly improper for a consultant to engage on any basis during the period of his contract any engineering or technical personnel in the employ of the public agency which is the other party to the contract, or for such employees to accept such employment" (July issue, page 72).

Administrator Tallamy's July 3rd memorandum follows in full:

"The Federal-aid highway legislation requires that a state highway department shall have adequate powers and 'be suitably equipped and organized,' but the Bureau of Public Roads has always recognized that on occasion there would be need to employ consultants for projects requiring special technical skills and even for less difficult projects when a program is being expanded rapidly. We have consistently urged adequate salaries for state highway department employees, together with sound personnel policies covering employee benefits such as promotions, retirement, and annual and sick leave—all in the interest of building and maintaining strong State highway departments.

"The circular memorandum of December 28, 1956, entitled 'Employment of Consultants in the Federal-aid Program,' suggested a clause for inclusion in contracts for engineering services relative to hiring of public employees to give the highway departments the maximum opportunity to develop and maintain adequate engineering staffs. The proposed clause has been rather generally misinterpreted and has given rise to criticisms, some of which go rather far afield from both the intent and content of the memorandum. However, some valid objections have been raised and it has therefore been decided to withdraw the suggestion for use of this clause, leaving the matter entirely to the discretion of the individual State highway departments.

"In approving contracts for consulting services on Federal-aid highway projects, division engineers should ascertain that consulting engineers are not only qualified technically but are organized and have the manpower to handle the work with necessary promptness. In the case of Interstate projects, steps must be taken to insure that the consultant is entirely conversant with the design standards required for such projects.

"Please advise the state highway departments regarding this new policy of the Bureau relative to employment of public employees suggested in the circular memorandum of December 28, 1956, for inclusion in contracts for engineering services. The mandatory clause in the December 28, 1956, memorandum relative to contingent fees *shall continue to be used* in all contracts with consultants involving Federal-aid projects."

1957 Nuclear Congress Proceedings for Sale

Availability of the proceedings of the 1957 Nuclear Congress in three volumes at a special prepublication price is announced by the American Society of Mechanical Engineers. The congress, which was held in Philadelphia last March, explored every phase of peaceful uses of the atom.

For orders received before September 15 the special rate will be $35 for three volumes; the price after that date will be $45. A single volume may be ordered at $17.50 per copy. Orders should be sent to the ASME, 29 West 39th Street, New York 18, N. Y.

ASCE QUARTERLY ENGINEERING SALARY INDEX

Consulting Firms

City	Current	Last Quarter
Atlanta	1.10	1.10
Baltimore	1.09	1.02
Boston	1.07	1.07
Chicago	1.12	1.06
Denver	1.11	1.04
Houston	1.04	
Kansas City	1.14	1.06
Los Angeles	1.12	1.14
New Orleans	1.00	1.00
New York	1.15	1.11
Pittsburgh	1.05	1.05
Portland	1.08	1.06
San Francisco	1.13	1.09
Seattle	1.05	1.05

Highway Departments

Region	Current	Last Quarter
I, New England	0.80	*
II, Mid. Atlantic	1.11	
III, Mid. West	1.16	
IV, South	1.05	
V, West	0.93	
VI, Far West	1.06	

Figures are based on salaries in effect as of May 15, 1957. Base figure, the sum of Federal Civil Service, G.S. Grades 5, 7 and 9 for 1956, is $15,930.

* No figures are given for the last quarter in the Highway Department category because the scope of the index was widened and the figures for the two quarters are not truly comparable.

Engineering Foundation Grants Go to Twenty-Eight Projects

Engineering research will go forward on a wide front with new grants made by Engineering Foundation, a department of United Engineering Trustees, Inc., at its annual meeting held in New York on May 16. Appropriations for the 1957-1958 fiscal year total $69,000. They will initiate or advance 28 projects, which will receive nearly $1,000,000 in industry support. The projects to which funds have been allocated represent all the important branches of the profession. They are being carried out in university, government, and industrial laboratories all over the country under sponsorship of the major engineering societies.

This year Engineering Foundation is making a special grant of $3,500 for an important new project of the Column Research Council, which promises ultimately to yield safer, cheaper structures. The special grant—contingent on the project's receiving an equal amount of outside support—will be used in preparing a general guide for the preparation of specifications on the subject of metal columns and compression members. The new project is aimed at making use of new data relating to the strength of compression members by offering the profession an over-all guide, with optional clauses covering a variety of situations. It will supplement rather than supplant existing specifications and make available for practical application the results of scientific research. The proposed guide will be dedicated to the late Shortridge Hardesty, Hon. M. ASCE, long-time member and chairman of the Column Research Council.

In the eleven years of its existence the Council, which is under the auspices of ASCE, has accumulated a great deal of valuable material on column behavior. Council headquarters have recently been changed from Lehigh University to the University of Michigan.

Alloys of Iron Research is receiving $5,000 to continue its work of publishing monographs devoted to important findings on carbon and alloy steels and cast irons. Alloys of Iron Research has been receiving Engineering Foundation support since its formation in 1929. It is a project sponsored by the AIME.

An allocation of $4,000 goes to the Corrosion Research Council—also an AIME-sponsored project—which completed its first year on December 31, 1956. One of the scientifically important facts already revealed by the Council's first program is that light slows down the rate of corrosion in water containing air.

Studies in High-Temperature Steam Generation, a long-time project sponsored by the ASME, will be given a token grant of $1,000. The latest development in this program is that, on the basis of findings of prototype equipment previously operated at the Naval Engineering Experiment Station at Annapolis, test equipment for determining the behaviour of alloy steels under high-temperature steam has been installed at the Philip Sporn Power Plant at New Haven, W. Va.

Of considerable concern to residents of coastal areas as well as to beachfront property owners is another research program that continues to receive Engineering Foundation support. The Council on Wave Research, which was set up to survey the various fields of water-wave action, had its origin in the Hydraulics Division of ASCE. It is now operating as an independent program. In its seven years of operation the Council has sponsored numerous conferences on coastal engineering and allied subjects. This fall it will have its Sixth Conference on Coastal Engineering, to be held in Florida under sponsorship of the University of Florida.

Since its formation in 1914 the Foundation has made sound use of its relatively modest income to initiate and develop important research programs that were later able to attract large-scale industrial backing. Its current endowment fund of about $1,500,000 includes a residual bequest of some $400,000 recently made available to it from the estate of the late Edwin H. McHenry, M. ASCE, civil engineer and railroad executive.

Tellers Canvass Ballot for 1958 Officers

July 1, 1957

To the Secretary
American Society of Civil Engineers:

The Tellers appointed to count the Ballot for Official Nominees report as follows:

For Vice-President—Zone I

(Term October 1957-October 1959)

Waldo G. Bowman	398
Jewell M. Garrelts	67
Scattering	318
*Ineligible Candidate	81
Void	0
Blank	42
Total	906

For Vice-President—Zone IV

(Term October 1957-October 1959)

Samuel B. Morris	1,125
Frederick W. Panhorst	312
Scattering	290
*Ineligible Candidate	256
Void	3
Blank	22
Total	2,008

For Director—District 1

(Term October 1957-October 1960)

Philip C. Rutledge	281
Marcel P. Aillery	32
Scattering	183
*Ineligible Candidate	36
Void	0
Blank	19
Total	551

For Director—District 2

(Term October 1957-October 1960)

Weston S. Evans	290
Scattering	15
*Ineligible Candidate	4
Void	0
Blank	2
Total	311

For Director—District 6

(Term October 1957-October 1960)

Tilton E. Shelburne	398

Scattering	41
*Ineligible Candidate	65
Void	0
Blank	0
Total	506

For Director—District 9

(Term October 1957-October 1960)

Craig P. Hazelet	455
Scattering	52
*Ineligible Candidate	28
Void	0
Blank	2
Total	537

For Director—District 10

(Term October 1957-October 1960)

Donald H. Mattern	384
Clifford D. Williams	280
Scattering	24
*Ineligible Candidate	43
Void	2
Blank	0
Total	733

For Director—District 11

(Term October 1957-October 1960)

John E. Rinne	1,066
Scattering	115
*Ineligible Candidate	87
Void	2
Blank	23
Total	1,293
Total number of ballots counted	6,845
Ballot envelopes without signature	5

Respectfully submitted,
ANTHONY N. MAVROUDIS
Chairman
JOHN B. WOOD
Vice-Chairman

Robert W. Richards — Sydney Harris
John D. Welch — Frederick H. Bielefeld
Anthony J. Galioto — Robert M. Perry
William C. Stevens — *Tellers*

* These votes were cast for incumbent officers who are presently ineligible for reelection in accordance with Section 9, Article VI of the Constitution.

Division Doings

Air Transport Division's Committee on Terminal Facilities

How can engineers be sure of keeping up with the latest developments in air terminal design and construction? Answers to this question were sought at a recent meeting of the Air Transport Division's Committee on Terminal Facilities held in New York.

As a first step, it was decided to assemble a comprehensive bibliography of available material on existing terminals and on new developments in the aeronautical field in so far as they affect terminal design, construction, and operation. To stimulate interest in improved design techniques, the group will sponsor Local Section meetings devoted to specific phases of the terminal design problem. In planning terminal buildings, the committee considers it essential to study the entire airport picture with reference to such diverse factors as cargo, mail, ramp refueling, apron services, and helicopter facilities. As to financing problems, it was the consensus that the effect of present techniques in the use of grants-in-aid to airport and airport terminal financing should be explored.

The make-up of the committee, which includes representatives of consulting engineering firms and airport and airline personnel, assures a diversified approach to the problem. The 1957 Official Register names the committee members, headed by John M. Kyle, Jr.

Committee on Cold Weather Construction Expanded

The scope of the Construction Division's Committee on Cold Weather Construction, which has been pretty much confined to construction in permanent frost areas, is being enlarged to encompass adverse weather construction. The new committee—set up to collect, distribute and coordinate knowledge essential to engineering and construction in adverse weather—will be called the Committee on Adverse Weather Construction. The present Committee on Cold Weather Construction, with Palmer W. Roberts as chairman, will be a subcommittee of the newly formed group.

Hydraulics Division Conference

The important Hydraulics Division news, of course, is its forthcoming annual conference, set for the M.I.T. campus, August 26-28. In case you missed the program in the July issue (page 65), this will remind you that technical sessions are being readied by six Hydraulics Division committees—Research, Design, Tidal Hydraulics, Hydrology, Floods, and Sedimentation.

At a recent meeting of the Division's Committee on Design, the Task Force on Nomanclature for Hydraulics reported that its glossary card file is complete (as of the moment) with 5,476 items. The file is being reviewed by members of the committee, and will also be referred to the other design committees in the Division. Plans for publishing the glossary will be discussed with the Executive Committee at its next meeting.

First Meeting for Power Division's Committee on Nuclear Energy

Long-range plans for operation were made by the Power Division's Committee on Nuclear Energy at its first meeting, which took place in Buffalo in June. The committee will cooperate with other groups in the field in sponsorship of programs. Programs are already being arranged for the Chicago Convention in February 1958 and the Annual Convention in October 1958. The committee will also participate in the Nuclear Congress to be held in Chicago in March 1958. The training and education of engineers for nuclear power work was reviewed at the group's Buffalo meeting.

In October, John F. Bonner, assistant to the vice-president and chief engineer of the Pacific Gas and Electric Company, San Francisco, will become a member of the Power Division's Executive committee for the term ending in October 1961. He will succeed Henry Lutge also with the Pacific Gas and Electric Company, whose term is expiring.

Sanitary Engineering Division

Nuclear energy and the disposal problems presented by this expanding field will be spotlighted in forthcoming Sanitary Engineering Division programs. At a recent planning session of the executive committee of the Division in Oklahoma City, arrangements were suggested for a Convention program consisting of three sessions and including twelve papers.

Soil Mechanics and Foundations Division

To make it clear that rock-fill dams come within its scope of interest, the Committee on Earth Dams of the Soil Mechanics and Foundations Division is debating the advisability of changing its name to include coverage of this type.

T. M. Leps is resigning as chairman of the committee after two years in the important post. He will be succeeded by P. T. Bennett, of the Corps of Engineers at Omaha, who will take office in October.

In the Structural Division

Myle J. Holley, associate professor of structural engineering at Massachusetts Institute of Technology, has accepted the secretaryship of the Structural Division's Executive Committee, starting in October.

The Division's new committee on high-speed computing machines (July issue, page 83) has changed its name from the Committee on Digital Computers to the Committee on Electronic Computation. Heading the committee is Prof. Nathan Newmark, of the University of Illinois.

Membership in the Structural Division's Control Group for the Committee on Nuclear Structures and Materials includes David L. Narver Jr., chairman; Abbott Frank, of General Electric; Herbert Glen, of the Oak Ridge National Laboratory; Prof. Jerome Raphael, of the University of California; and Prof. John Goldberg, of Purdue University.

At a meeting of the Division's Committee on Activities in the Building Field, held in Buffalo in June, it was unanimously decided that there is no need to set up a separate Architectural Engineering Division. It was the consensus that by broadening its activities the Structural Division can well serve engineers whose primary interests lie in the building field.

New Technical Division Personnel Appointed

At its Buffalo meeting in June, the Board of Direction approved a number of new appointments and extensions of terms of appointees to the executive committee of the Technical Divisions. The new appointments follow:

Air Transport Division: Appointment of Ronald M. White for the term ending in October 1961. Extension of the term of Robert Hononjeff from October 1959 to October 1960.

City Planning Division: Appointment of Everett N. Mansur for the term ending in October 1961. Extension of the term of J. Cal Callahan from 1959 to 1960.

Construction Division: Appointment of Walter L. Couse for the term ending in October 1961. Extension of the term of Warren N. Riker from 1959 to 1960.

Engineering Mechanics Division: Appointment of Egor P. Popov for the term ending in October 1961.

Highway Division: Appointment of John O. Morton for the term ending in October 1961. Extension of the term of Harmer E. Davis from 1957 to 1958. Extension of the term of Archie N. Carter from 1959 to 1960.

Irrigation and Drainage Division: Appointment of Kenneth Q. Volk for the term ending in October 1961. Extension of the term of John H. Bliss from 1959 to 1960.

Pipeline Division: Appointment of William T. Ivey for the term ending in October 1961.

Power Division: Appointment of John F. Bonner for the term ending in October 1961. Extension of the term of George J. Vencill from 1959 to 1960.

Sanitary Engineering Division: Appointment of Lewis A. Young for the term ending in October 1961. Extension of the term of Ray E. Lawrence from 1959 to 1960.

Soil Mechanics and Foundations Division: Appointment of Thomas M. Leps for the term ending in October 1961. Extension of the term of Ralph E. Fadum from 1959 to 1960.

Structural Division: Appointment of Elmer K. Timby for the term ending in October 1961.

Surveying and Mapping Division: Appointment of Earle J. Fennell for the term ending in October 1961. Extension of the term of Milton O. Schmidt from 1959 to 1960.

Waterways and Harbors Division: Appointment of Lawrence B. Feagin for the term ending in October 1961. Extension of the term of Roger H. Gilman from 1959 to 1960.

EJC Publications Available

A wide range of professional interests is covered in publications of Engineers Joint Council. Currently on hand are the following items, which may be obtained from EJC headquarters, 29 West 39th Street, New York 18, N. Y. There is no charge except as noted.

1. "Engineering Manpower Convocation," Sept. 28, 1951, Pittsburgh, 60-page booklet with proceedings and supplements.
2. "Proceedings of the Conference on Manpower Utilization and National Security," Sept. 7, 1952, Chicago, 56-page booklet.
3. "Principles of a Sound National Water Policy," July 1951, 233-page paper-bound report, $1.50.
4. "Proceedings of Conference on Engineering Manpower Utilization Methods," Oct. 16, 1953, 35-page booklet.
5. "Demand for Engineering Graduates—1956," 9-page mimeographed report, published in July 1956.
6. "Engineering Faculties"—text and tables on supply-demand and salary structure of engineering educational staffs; 11-page mimeographed report, published in October 1956.
7. Report 101, "Raising Professional Standards and Improving Employment Conditions for Engineers," 14-page booklet published in 1956.
8. Report 102, "Professional Income of Engineers, 1956"; 36-page booklet, published in 1957, $1.50.
9. Report, "Proceedings of the Third General Assembly of EJC," Jan. 17-18, 1957. May 1957, $1.00.
10. Report 104, "Engineering Educational Facilities," May 1957, 25 cents.
11. Report 105, "Principles of a Sound National Water Policy"—a restatement of the 1951 EJC report, May 1957, 25 cents.
12. "Voice of the Engineer"—one-page statement of EJC objectives and activities.
13. "Annual Report—1956, of Engineers Joint Council," 40-page booklet describing EJC organization and activities, April 1957.
14. "Engineer"—one-page newsletter on current activities of EJC; available on request to sections or chapters of engineering and professional societies.

Subscriptions will be accepted for the EMC-EJC Newsletter—a four-page bimonthly publication of the Engineering Manpower Commission of EJC and the Scientific Manpower Commission. There is no charge for the newsletter, which is concerned with current technological manpower and educational problems.

ASCE CONVENTIONS

ANNUAL CONVENTION

New York, N. Y.
Hotel Statler
October 14-18

CHICAGO CONVENTION

Chicago, Ill.
Sherman Hotel
February 24-28, 1958

PORTLAND CONVENTION

Portland, Ore.
Multnomah Hotel
June 23-27, 1958

TECHNICAL DIVISION MEETINGS

HYDRAULICS CONFERENCE

Cambridge, Mass.
Mass. Inst. of Tech.
August 26-28

WATERWAYS & HARBORS CONFERENCE

Princeton, N. J.
October 18
(Part of Annual Convention program)

LOCAL SECTION MEETINGS

Illinois—Weekly luncheon meetings at the Chicago Engineers Club every Friday at 12 noon.

Sacramento—Weekly luncheon meetings at the Elks Temple every Tuesday at 12 noon.

Texas, New Mexico, Mexico—Joint fall meeting in El Paso, Tex., September 26-28.

ASCE Membership as of July 9, 1957

Members	9,593
Associate Members	12,920
Junior Members	17,440
Affiliates	74
Honorary Members	46
Total	40,073
(July 9, 1956	39,236)

NOTES FROM THE LOCAL SECTIONS

(Copy for these columns must be received by the fifth of the month preceding date of publication)

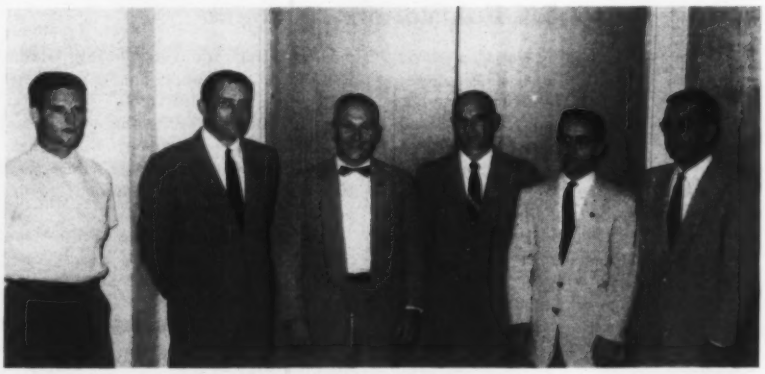
Central Illinois Section heard a stimulating talk on the development and uses of particle accelerators, which are designed to disintegrate atoms, thus throwing light on their arrangement and makeup. A lively discussion followed. Featured speaker was Dr. John J. Livingood, director, Particle Acceleration Division, Argonne National Laboratory. At this annual joint meeting with the University of Illinois Student Chapter, President Gardner presented Section awards to three outstanding Student Chapter members—Steven J. Fenves, Lyman W. Heller and Brantley M. Kelehar, Jr., Kenneth W. Derby and Clarence Hauschild, two other seniors at the University, are scheduled to receive similar awards from the **Illinois Section.**

Three Student Chapter members—Franklin D. Thomas, Alan Stebnar and Edward Spira—were in charge of the annual joint meeting of the **Cleveland Section** and the Case Institute of Technology Student Chapter. Following their talks, the G. Brooks Earnest Award was presented to Robert E. Bathen of Fenn College, and to James S. Harris of Case Institute of Technology. The Cleveland Section awards went to Donald Mandalfino of Fenn College, and Emil C. Hack, of Case Institute.

Congratulations to the **Dayton Section,** whose fine new publication *The Tripod* joins the list of Section news letters. The editors have pledged themselves to turn out a publication that will "make you want to pick it up to read as soon as it's delivered." It will present interesting and amusing Society and technical notes. The Dayton Section and the Engineers Club of Dayton were joint hosts at a recent dinner meeting at which Francis Friel, Dr. Abel Wolman and Frank Leggette as the board of consultants for the Miami Conservancy District, presented a preview of their report on the feasibility of improving the water resources of the District. A lively discussion followed.

Slated to preside over the **Delaware Section** in 1958 are James D. Wilson, president; Paul J. Brennan, vice-president; and Horace L. Lefferts, secretary-treasurer.

Members of the **Central Savannah River Valley Branch** of the **Georgia Section** recently heard an informative discussion on "optical tools for alignment,"



Gainesville Branch of Florida Section and University of Florida Student Chapter are joint hosts at meeting featuring talk by Don P. Reynolds, Assistant to the Secretary of ASCE. Photographed here (left to right) are T. J. McCarthy, Jr., president of the Chapter; Mr. Reynolds; Hubert F. McDonell, president of the Florida Section; Byron D. Spangler, vice-president of Section; R. W. Pride, president of Gainesville Branch; and C. C. Hill, vice-president of Branch.

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Kodak

Mid-South Section's Jackson and Vicksburg Branches join forces for an evening of good fellowship. Highlight of the evening was the presentation of awards honoring the efforts of the Jackson Convention planners. Shown, left to right, are A. L. Grubbs, manager of Heidelberg Hotel; Lee Bonner, convention manager for Jackson Chamber of Commerce; Mrs. J. F. Redus, Jr.; Mrs. R. W. Sauer; Mrs. Norman R. Moore; ASCE Vice-President Norman R. Moore; Mrs. Arthur C. Miller; J. F. Redus, Jr., president of Vicksburg Branch; Arthur C. Miller, president of Jackson Branch; R. W. Sauer, president of Mid-South Section; Mrs. Sydney W. Chandler, chairman of Convention Ladies Committee; and Sydney W. Chandler, Convention chairman.

Michigan Section officers greet ASCE President Mason Lockwood at joint meeting with University of Michigan Student Chapter, held during recent commencement season. In usual order are Prof. Lloyd T. Cheney, president of Section; Director Harry L. Conrad; Mr. Lockwood, who was featured speaker; Leonard L. Klein, secretary-treasurer of Section; and Elihu Geer, first vice-president. Certificates of life membership were presented to Section members Earnest Boyce, John G. Claybourn, and Harry E. Miller. John Kohl, former Section president, was honored with a "Distinguished Service Award" for his services to the profession during his presidency.

presented by Harold R. Osmick, consultant for the Du Pont Engineering Department in Wilmington. The Branch has generously offered to aid the Augusta Library in the selection of technical books for its proposed Scientific Section, when the library has moved into its new quarters.

A noisy but entertaining quintet of instrumentalists and vocalists presented its impression of the "rock and roll era" for **Kansas Section** members and their wives. The second feature of this recent meeting was a stimulating discussion of ASCE at the national level. Norman R. Moore, vice-president of Zone III, briefly outlined the structure and function of various Society committees, and discussed some of the problems and projects confronting national officials at present.

The **Kentucky Section** announces that its annual traditional Junior Membership awards have been presented to Bob N. Hancock of the University of Louisville, and H. G. Perry of the University of Kentucky, as outstanding members of the senior engineering class. John T. Huson, University of Louisville, won first prize in the Student Technical Paper Competition in Louisville. Winners in second and third place were H. G. Perry and W. J. Deatrick, of the University of Kentucky.

The preliminary findings of a current study on continuously reinforced concrete pavement were revealed to members of the **Lehigh Valley Section** at a recent meeting. Under the sponsorship of the American Iron and Steel Institute, the Pennsylvania Department of Highways, and the Bureau of Public Roads, researchers are seeking a method of reducing highway maintenance and construction costs, and providing a "bump-free" ride by the elimination of transverse joints in the pavement. Prof. Robert L. Schiffman of Lehigh University discussed the early and encouraging findings of the group. E. L. Durkee, a Director of ASCE, spoke briefly on the possible formation of a joint council for District 4.

Entertainment and fun were on the agenda of a recent **Maryland Section** meeting. This meeting, traditionally marked as a social event, afforded members the opportunity of becoming better acquainted with one another.

A problem of growing importance in these times of increasing urbanization, was discussed at a meeting of the Sanitary Engineering Division of the **Metropolitan Section.** "Incinerator Design and Operation" was considered by a panel of experts—Vigo Westergaard, New York City Department of Public Works; Norman Wagner, Superintendent of Refuse Disposal, Stamford, Conn.; Abraham Michaels, Philadelphia Refuse Disposal Department; Morris Klegerman, consulting engineer, New York City; and Leo P. Flood, New York City Department of Air Pollution Control. William Foster, editor of *American City Magazine,* was moderator. The Section has designated Howard L. King, vice-president and chief engineer of Mason and Hanger-Silas Mason Co. Inc., as Metropolitan Civil Engineer of the Year. Mr. King directed the construction of the north and south tubes of the Lincoln Tunnel, and was consultant on the new third tube. At the helm of the Section for the coming year will be Roger H. Gilman, president; Michael N. Salgo, vice-president; and William J. Shea, treasurer.

Flood control in the Valley of Mexico was the subject of an informative talk delivered to the **Mexico Section** by Andres Garcia-Quintero, chief engineer of construction works of the Valley of Mexico. At the Section's recent dinner meeting members were notified of the Board of Direction's decision to confer the grade of Honorary Member upon Lorenzo Perez Castro, past-president of the Section.

high-speed freeways start quicker . . .
are completed sooner with
REINFORCED CONCRETE

From coast to coast, highway engineers are finding that reinforced concrete bridges start sooner and progress faster because all necessary materials and labor are readily available from local sources. Structures of reinforced concrete can save months of delay.

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On your next bridge or overpass, design for rugged beauty plus economy . . . design for REINFORCED CONCRETE.

A southerly view of a recently completed section of the Harbor Freeway, U. S. Highway 6, Los Angeles

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At Kansas City Section's final meeting of season, Section President W. G. Riddle (right), congratulates John H. McCann, Jr., 1957 recipient of a summer scholarship award given by the Armco Drainage and Metal Products Company. Young Mr. McCann is a senior in the University of Kansas engineering school and member of the Society's Student Chapter there. His father, Section Member J. M. McCann, Sr., smiles proudly. Featured speaker was Bill Moore, veteran reporter for "Kansas City Star," who discussed the International Geophysical Year.

After a very enjoyable social hour and dinner, which was held in the officer's open mess at Fort Leonard Wood, the joint meeting of the **Mid-Missouri Section** and the Fort Leonard Wood Section of the Society of Military Engineers, Maj. Gen. Emerson C. Itschner, chief, Corps of Engineers, gave an interesting talk on "The Military Engineer's Role in a New Era." Slides showed schematic diagrams with detailed specifications for the new methods of producing fuels for guided and ballistic missiles, new equipment used by Army Engineers, and nuclear power plants.

An exciting illustrated talk on a trip to South America was given before the **Mid-South Section's Little Rock Branch** at a recent meeting. Eugene F. Bespalow, vice-president and chief engineer of Choctaw Inc., was the speaker. At the **Memphis Branch** meeting, J. M. Trissal, chief engineer of the Illinois Central Railroad, presented an interesting account of the problems encountered in locating the Prudential Building over the Illinois Central Air Rights in Chicago.

By unanimous action, the **National Capital Section** has recommended to the District of Columbia Committees of the Senate and the House of Representatives that the Professional Engineers' Registration Act of the District of Columbia not be modified to allow any relaxation in the requirements for certification of plans, specifications and reports by anyone except a registered professional engineer. An inspection of the Washington Aqueduct facilities, under construction at the Delecarlia pumping station, and Little Falls Dam was made possible for members and guests of the National Capital Section by invitation of Col. George B. Sumner, District Engineer of the Corps of Engineers. The tour was highly instructive, as construction work was at an ideal stage for inspection.

Highlighting the program of a recent meeting of the **Central Pennsylvania Branch, Philadelphia Section,** was an address by Vice-President Francis S. Friel. He presented an up-to-date account of current Society activities. A certificate of Life Membership was presented to Charles H. Buckius, former chief engineer of the Pennsylvania Department of Highways. The new Branch officers were installed by Vice-President Friel, as follows: John J. Molloy, president; F. L. Morgenthaler, Jr., vice-president; Hugh B. Henry, secretary-treasurer; and Marlin L. Sheridan, councilor. Members of the **Trenton Branch** were recently guests at a Princeton University Student Chapter meeting. C. W. Hanson of Modjeski and Masters, and Milton Brunner of Ammann and Whitney presented an illustrated discussion of the Walt Whitman bridge. The Branch has voted to present annual awards to the principal authors of the two best Student Chapter papers. Awards this year went to Richard T. Sparks for his paper, "Load Shortening of Thin Plates in Compression" and to Howard P. Colhoun, for research on fibre glass for use as reinforcement in prestressed concrete.

H. E. Bradshaw (left), member of Texas Section's Dallas Branch, chats with future engineer Calvin Justus and Lyman C. Josephs, chief engineer of aircraft design for Chance-Vought, at annual dinner dance for future engineers sponsored by Dallas Engineers Club. Dallas Branch took an active part in sponsoring the party for some 300 high school seniors.

A slate of officers for the coming year has been elected by the **Rhode Island Section.** They are: John F. Westman, chairman; Harold Bateson, vice-chairman; and Charles N. Bissell, secretary-treasurer. Following the election, ASCE Executive Secretary Wisely spoke, followed by Dr. William Metz of the University of Rhode Island, who discussed Rhode Island canals.

A very illuminating talk and film on the design and construction of atomic containment vessels were presented to the **San Diego Section** by Dean Stephan, district sales manager for the Los Angeles office of the Chicago Bridge and Iron Co. A lively question-and-answer period followed. John Brainard, an associate of Mr. Stephan, briefly discussed the design of a wind tunnel that is now under construction at Convair in San Diego.

C. H. Ferguson, district manager of Intrusion-Prepakt Inc., discussed the company's work in the concrete renovating business at a recent meeting of the **Spokane Section.** Accompanying his informal talk with slides, Mr. Ferguson illustrated the company's method of rebuilding eroded concrete structures.

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PENNSYLVANIA: Laykold® Asphaltic Concrete solves a tough paving problem on the Liberty Bridge, a major approach to downtown Pittsburgh. (When it comes to pavements, bridges are notoriously "bad actors" because expansion and contraction of the deck result in an unusual degree of movement under the surfacing). Based on previous use of Laykold Asphaltic Concrete, Department of Public Work officials for Allegheny County knew that this material retained an extra measure of resilience after placement and compaction, with no decrease in load-bearing value.

Mixed with slag aggregate, a 120 lb. "LAC" binder course and a 100 lb. "LAC" surface course were placed over an area of some 32,000 sq. yds. Trumbull Construction & Asphalt Company of Pittsburgh did the work. American Bitumuls & Asphalt Company supplied the asphalt and the Laykold Tempering Fluid.

Results to date: excellent service; no pavement failures.

CALIFORNIA: Across the nation, on the Pacific Coast, the State of California Department of Highways let a half-million-dollar contract for re-surfacing 41 miles of U. S. Highway 99 to the Schroeder Company, of Sun Valley, California. For this job, American Bitumuls & Asphalt Company supplied: 1,700 tons of Air Refined Asphalt; 3,500 tons of Paving Asphalt; 140,000 gallons of Bitumuls® Emulsified Asphalt.

LOUISIANA: While "down South," on the construction of a road for private industry at Grand Isle, La., American Bitumuls & Asphalt Company supplied Bitumuls Emulsified Asphalt for 20,000 sq. yds. of 3-course surface treatment work on which *clam shells* were used as aggregate. As cover aggregate, shell produces a long-wearing surface.

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BY-LINE WASHINGTON . . . . .

The smoldering controversy of Portland cement concrete versus asphaltic concrete for military air field pavement burst into the open last month before a Congressional investigating committee. Engineers on both sides of the fence vigorously argued the merits of each material before a Subcommittee of the House Armed Services Committee. The Committee had called the witnesses during an inquiry into the Air Force's policy of favoring rigid-type pavement.

The Air Force engineers—citing field experience—dogmatically stuck to their assertion that Portland cement concrete pavements hold up while asphaltic concrete fails under today's huge bombers. The Asphalt Institute, contesting these complaints, argued that none of the asphalt taxiways which had failed had been designed for the traffic they were later subjected to. In essence, the asphalt people declared, the failures were failures of inadequate design, not of material.

Engineers from the Corps of Engineers flexible pavement research laboratory revealed during the course of the hearings that heavy duty asphaltic concrete pavement design is fast catching up to that already available for Portland cement concrete. "We have developed an asphalt pavement design we are confident will bear 100,000 lb on dual wheels and are on the threshold of a design capable of bearing 325,000-lb loadings," Corps experts reported.

* * *

The Bureau of Public Roads has decided to rescind its so-called "anti-raiding" directive, Federal Highway Administrator Bertram Tallamy told *Civil Engineering* last month. In revoking the policy, Mr. Tallamy said, "We have decided to leave the matter entirely to the discretion of the individual state highway departments."

* * *

The 10-year-long fight for a high federal dam at Hells Canyon on the Snake River has finally died out, after a last-ditch drive in Congress last month. Public power advocates have long battled for a 722-ft-high concrete arch dam costing about $354 million and financed by Uncle Sam. The ambitious federal scheme was rejected by the last session of Congress, and a private power company was authorized to start construction of three smaller dams on the river, instead.

Then, in a vote-swapping operation that gave them a majority vote, the high dam advocates last month pushed through a measure by which the Senate would renege in its previous action and approve the single federal high-dam project. The public power rally was short-lived however. A House committee promptly killed the action and squelched any hope for the high dam proposal.

* * *

The St. Lawrence Seaway Development Corporation may borrow an additional $35 million to complete this mammoth undertaking, Congress ruled last month. Increases in the cost of construction and planning and design changes made the move necessary. The project is at the height of construction this season.

* * *

Civil engineers would be distinctly affected by proposed federal legislation permitting the National Labor Relations Board to certify unions representing employees of contractors *without an election*, under certain circumstances. Some engineers are urging that the bill be revised to exempt professional employees without their having a chance to vote separately, as the Taft-Hartley Act now provides.

* * *

The much publicized right-of-way irregularities in a few federal-aid highway projects have led the Bureau of Public Roads to set up a watchdog Projects Examination Division. The new unit will keep an eye not only on right-of-way acquisitions made with federal money but also on construction practices. The agency has assigned federal right-of-way agents in each of its division offices, in addition, to double-check such deals.

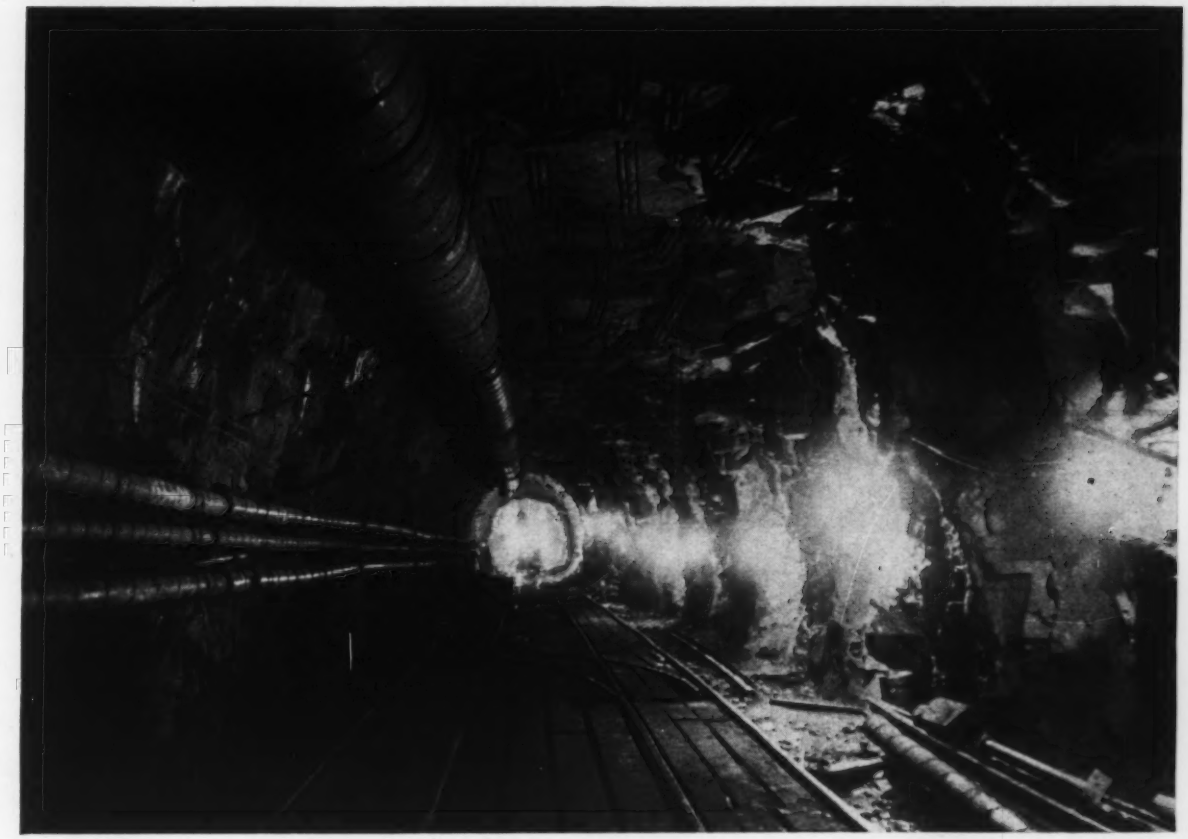
Land purchasing under the 16-year National Highway Program will reach its peak this year and next. David Levin, the Bureau's right-of-way expert, reports that about 650,000 separate parcels must be acquired upon which to locate the 41,000-mile network of superhighways. Their cost—about $5 billion. These expenditures —about 20 percent of the total cost of the Interstate System—will be concentrated within the first few years, to permit engineers to proceed with design. Federal officials are determined to prevent fraud and the kind of deals which newspapers are so quick to uncover and publicize to the detriment of the highway program.

* * *

A survey of construction specifications and working drawings is being launched by the Federal Construction Council. The objective—to improve those now in use by federal contracting agencies. The FCC is an informal group without specific authority, composed of representatives from all the federal agencies involved in construction—the Army Corps of Engineers, the Bureau of Reclamation, the Navy Bureau of Yards and Docks, the Veterans Administration, and the Housing and Home Finance Corporation. The National Bureau of Standards, because of its responsibilities in testing and standards, is particularly active in the group.

The Associated General Contractors of America has been asked to contribute recommendations for clarifying and simplifying federal construction specifications. The help of other industry or engineering organizations, also, may be solicited for this current study. The FCC may also survey some specialized construction methods, such as prefab panel, lift slab and precast concrete.

UNDERGROUND AIR-LIFT



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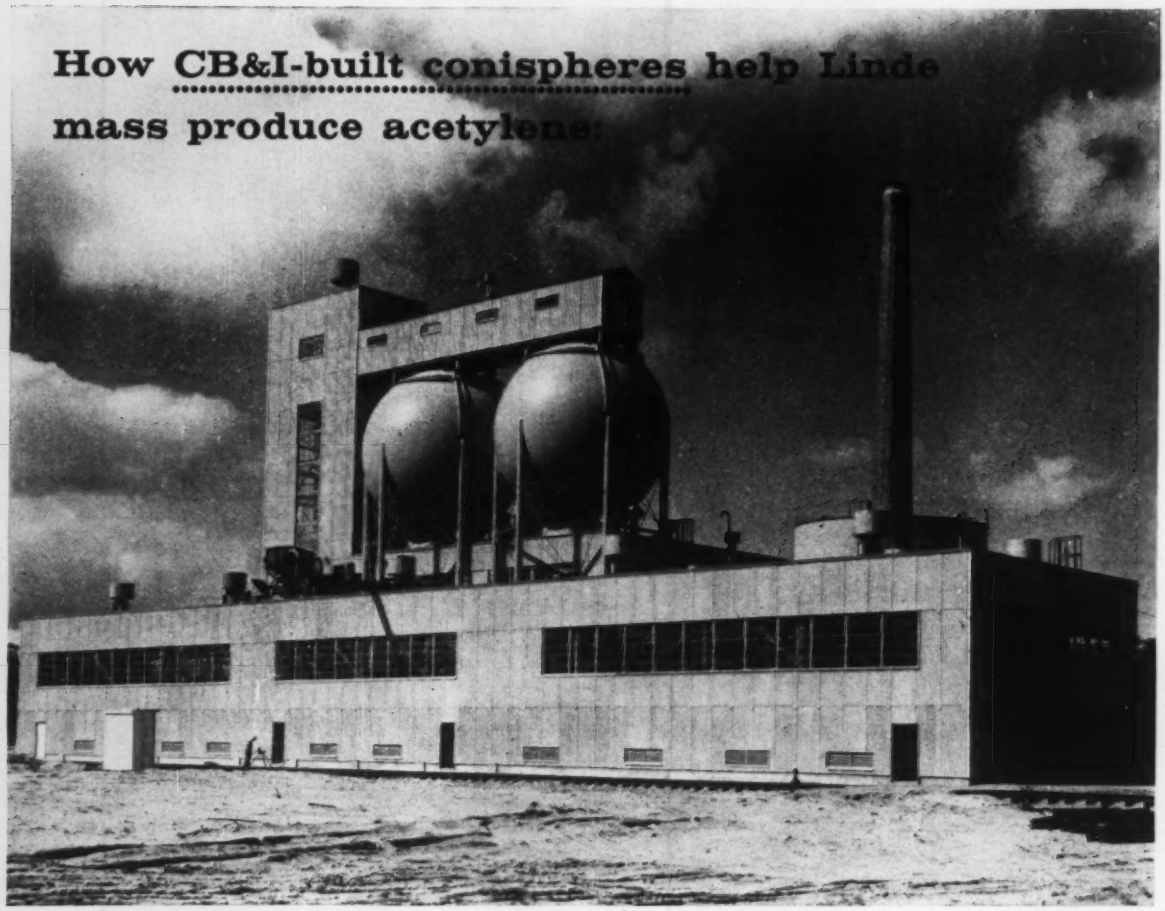
How CB&I-built conispheres help Linde mass produce acetylene.



Neoprene plant gets constant flow of raw material via direct pipeline.

The two 30-foot diameter CB&I-built conispheres (Hortonspheres® with conical bottom outlets) shown above serve as a vital link in Linde Company's new mass acetylene production plant at Montague, Michigan.

The 500-ton capacity structures are designed to keep a ready and free-flowing supply of calcium carbide available for generation into acetylene—one of the components for manufacturing *Neoprene*.

Through a unique "stockroom" arrangement Linde is able to maintain a steady flow of raw material to a nearby neoprene plant—via pipeline.

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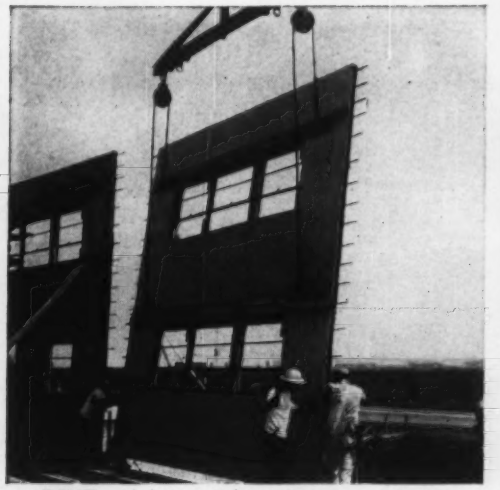

PANEL with large window areas

WAREHOUSE

DANIEL CONSTRUCTION CO. PHOTO

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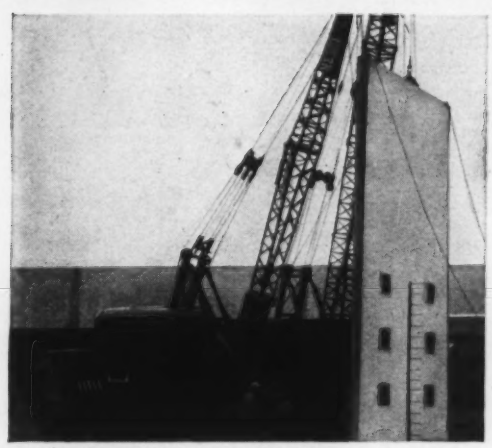
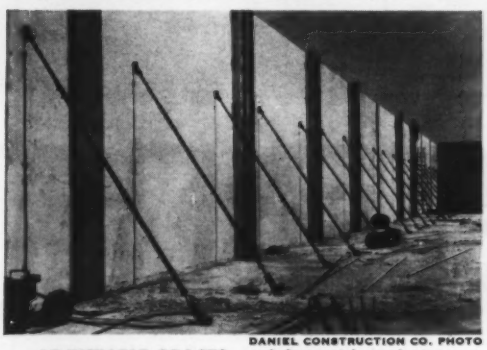


57 TON SLAB being positioned



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ADJUSTABLE BRACES used for quick and easy alignment of panels

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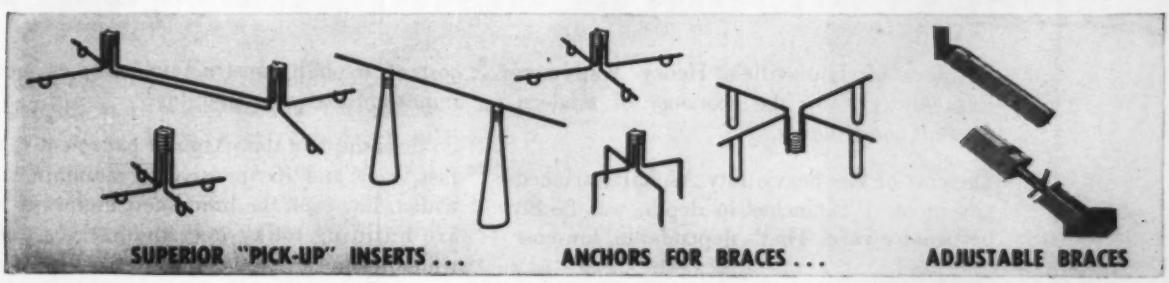

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Builders of Louisville's Henry Watterson Expressway know the *economy* of modern Asphalt construction.

The cost of this heavy-duty Asphalt surfaced pavement, 17¾ inches in depth, was $3.88 *per square yard*. That's dependable, low-cost highway!

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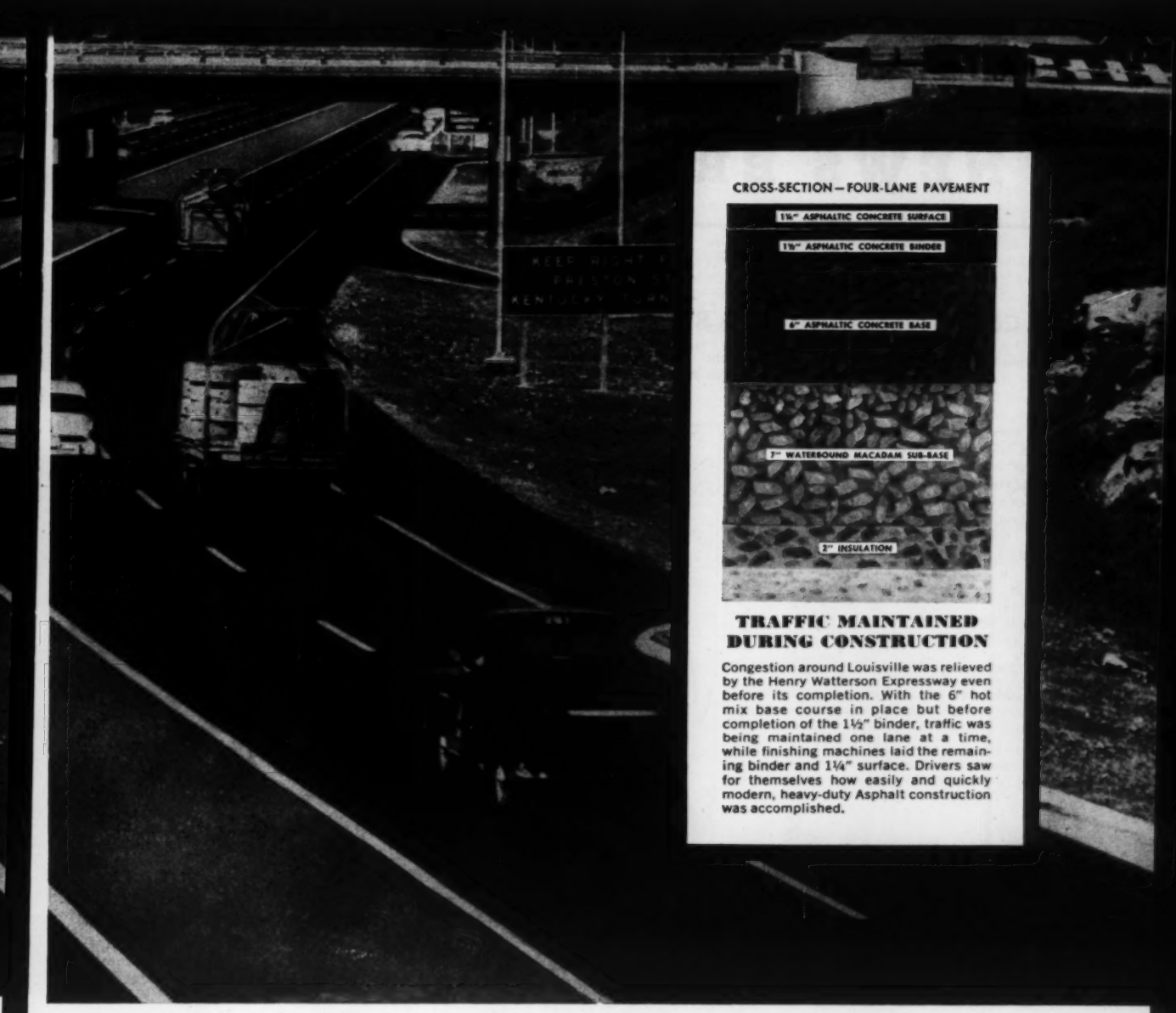
So does the fact that Asphalt pavement is so fast, easy and inexpensive to maintain and widen. For even the brand-new highways we are building today may themselves need widening and strengthening due to unforeseen *future* loads and traffic increases.

Save Tax Dollars — With modern Asphalt



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Congestion around Louisville was relieved by the Henry Watterson Expressway even before its completion. With the 6" hot mix base course in place but before completion of the 1½" binder, traffic was being maintained one lane at a time, while finishing machines laid the remaining binder and 1¼" surface. Drivers saw for themselves how easily and quickly modern, heavy-duty Asphalt construction was accomplished.

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June Construction Activity Sets Record for the Month

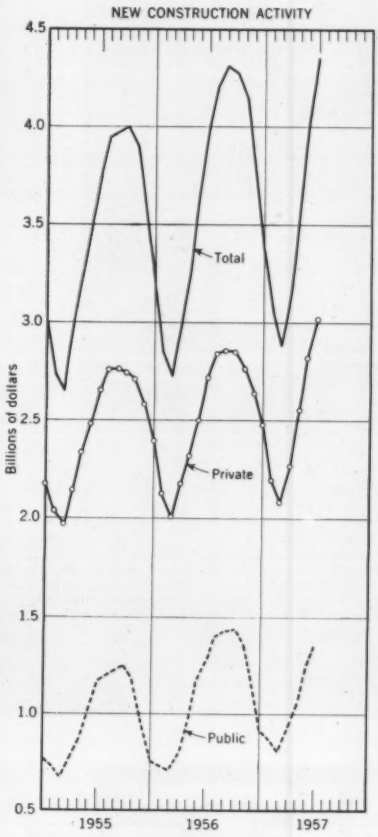
The value of new construction put in place in June rose seasonally to $4,354 million, slightly above the previous June record of $4,288 million set in 1956, according to preliminary joint estimates of the U.S. Departments of Commerce and Labor. Construction activity in the first six months of this year amounted to an all-time high of $21.5 billion, 3 percent above the figure reported for the first half of 1956. On a seasonally adjusted basis, outlays thus far in 1957 were at an annual rate of nearly $46.8 billion, compared with actual expenditures of $46.1 billion for the year 1956.

Virtually all types of construction shared in the 8 percent rise between May and June. Expenditures for residential additions and alterations, public utilities, and public schools rose to all-time highs. Outlays for private industrial buildings, offices and warehouses, highway construction, and sewer and water facilities set a record for the month of June.

Private construction during the month, at $3,012 million, was slightly below the June total, largely because spending for new housing, although above the May level, was off 12 percent from last June's volume. Public construction activity, however, reached a new June high of $1,342 million this year.

Private expenditures, which accounted for more than 70 percent of all new construction activity during the first six months of 1957, were almost equal to outlays in the first half of 1956. Declines in new dwellings, stores, and farm buildings were nearly offset by rises in the other types of private construction.

Public outlays for the half year at $6.2 billion, were 11 percent more than in the corresponding period last year, with all major types of construction, except military facilities, contributing to the increase.



New construction activity in June, at $4,354 million, represents 8 percent rise over May and sets new record for the month.

California Dedicates Its Tri-Dam Project

The Tri-Dam Project, a joint venture of the Oakdale Irrigation District and the South San Joaquin District, was formally dedicated on June 15. The dedication took place at the Beardsley Dam, about 150 miles east of San Francisco.

Three new dams—the Donnells, Beardsley, and Tulloch—are involved in the project, which will increase water storage on the middle fork of the Stanislaus River by 230,400 acre-ft and provide 81,000 kw of electric power contracted for by the Pacific Gas and Electric Company. The Donnells powerhouse is equipped with the largest vertical impulse-type hydraulic turbine—an Allis-Chalmers six-jet type unit—in the United States. The three-mile-long reservoir at Donnells, greatest hydroelectric power producer of the three dams, will store 64,500 acre-ft of water. Control center for the three projects is the centrally located Beardsley Powerhouse. Tulloch Dam, 45 miles downstream from Beardsley, is still under construction.

Engineering design for the Donnells powerhouse, Beardsley Dam and powerhouse, and Tulloch Dam and powerhouse was provided by the International Engineering Co., and for the Donnells Dam and Tulloch afterbay by the George E. Goodall Co. Tudor-Goodenough Engineers coordinated and supervised the engineering. Construction work for the Donnells and Beardsley units was handled by Tri-Dam Constructors, consisting of the Morrison-Knudsen Co., Inc., Peter Kiewit Sons Co., Stolte Inc., and Macco Corp. Construction of the Tulloch units was handled as a joint venture by the Arundel Corp. and the L. E. Dixon Co.

Thailand to Construct $100 Million Power Dam

Work is about to start on a $100 million multi-purpose dam, which will be built on the Ping River in northwest Thailand, 260 miles northwest of Bangkok. Many years in the planning, the dam will be one of the largest in Asia. Its primary purpose will be to provide badly needed electric power. According to experts, Thailand has one of the lowest supplies of electric power in the world, and the shortage has been retarding the industrial growth of the country.

The projected concrete dam will be 505 ft high and 1,510 ft long, comparable in size with the great dams in the United States. It will have storage capacity of 9,890,000 acre-ft, of which almost 7,000,000 acre-ft will be available for power release. The initial construction stage calls for two generators with an output of 140,000 kw—more than the country's entire supply at the present time. New generator units will be added over the years until 1981, when ultimate planned capacity of 560,000 kw will be reached.

Building the dam will be a five- to six-year job. Work will start as soon as government officials complete negotiations for a World Bank loan. The loan will be between $65 and $70 million. Thailand will put up the rest.

In February, Thailand dedicated a dam on the Chao Phya River, subject of an article in this issue.

Oklahoma Completes Its Second Turnpike

A new superhighway streaks across the Oklahoma prairie. Opening of the 88-mile Will Rogers Toll Road late in June now provides four-lane, limited-access travel between Oklahoma City and the Oklahoma-Kansas-Missouri border near Joplin, Mo. At Tulsa the new Will Rogers Road connects with the Turner Turnpike, a similar 88-mile toll road opened between Tulsa and Oklahoma City four years ago.

Built in two years, the new route cost $68,000,000—$30,000,000 more than its sister turnpike, largely because it has ninety small bridges. Like the Turner Turnpike, it will become a free state highway after the bonds are redeemed. Meanwhile, the passenger car toll is $1.45. De Leuw, Cather & Company, of Chicago, were the consultants on the Will Rogers pike.

Plans for two other toll roads, authorized by the Oklahoma Legislature in 1952, have been abandoned. One connection, originally intended as a toll road between Oklahoma City and the Kansas Turnpike, will be a freeway built with federal aid as part of the interstate system.

New Secretary for ASME

Oscar B. Schier, II, has been designated secretary-elect of the American Society of Mechanical Engineers by unanimous vote of the society's council. He will succeed Clarence E. Davies, who is retiring soon as secretary after 23 years in this administrative post. A member of the ASME staff for the past eleven years, Mr. Schier became assistant secretary in 1953 and deputy secretary last December. He was formerly associated with the Consolidated Edison Company of New York.

ESA Splits Over Policy

At the recent convention of the Engineers and Scientists of America (ESA) held in Los Angeles, May 29 to June 2, a significant event occurred. Several federated collective bargaining groups split off to form a new federation tentatively called the "Engineers and Scientists Guild" (ESG). Before the split ESA claimed to represent nearly 40,000 engineers. ESG seems to have taken about half of these people.

The reason for the split is the long-standing disagreement about the kinds of people who should be included in collective bargaining units. ESA believes membership in units should be limited to engineers who fit the Taft-Hartley definition of professional persons, that is, the unit should be homogeneous. The attitude of the ESG opponents is that membership should include technicians as well as professional engineers, if approved by those voting in the unit—that is, the unit could be heterogeneous for the purpose of strengthening the unit.

In this connection it should be recalled that in an NLRB election in May, the engineers at Minneapolis-Honeywell voted 974 to 429 in favor of a union composed of engineers only, if a union were certified (June issue, page 100). In that election, however, the majority of both engineers and technicians favored "no union."

Reelected to be president of ESA was Joseph Amann.

The leader of the ESG split is Charles Hall. An organization meeting has been planned for the fall. At present the ESG is composed of the Engineers Association, Sperry Gyroscope, N. Y.; the Tennessee Valley Authority Engineers Association; and the Engineers and Architects Association of Southern California.

Two Sewage Outfalls for Hyperion Treatment Plant

The $2,629,000 seven-mile-long ocean outfall sludge line for the City of Los Angeles' Hyperion Treatment Plant is now nearing completion. This line, consisting of 36,772 ft of pipe in 40-ft lengths, terminates in the ocean at the record-breaking depth of 300 ft. The unique method of installation required that the 22-in.-dia pipe be manufactured within very close tolerances. The 40-ft lengths were cleaned and primed, triple coated with Koppers 70B enamel reinforced with Fiberglas and wrapped with enamel-impregnated felt. These wrapped sections were then delivered to the Baldwin Park plant of the United Concrete Pipe Corp., where they were lined and coated with cement mortar.

Installation procedures of the Submarine Pipeline Construction Co.—headed by S. V. Collins—involved in essence pulling a continuous line of pipe, seven miles long and weighing 8,000,000 lb, out to sea. Actually the buoyancy of the empty pipe in salt water reduced the weight to about 147,000 lb. A 60,000-lb "pulling sled," was specially designed to serve as the pulling nose and, later, as an end anchor for the pipeline. The line was installed by Healy-Submarine-De-Long, a joint venture of the Healy Tibbitts Construction Co., San Francisco; the Submarine Pipeline Construction Co., Port Lavaca, Tex.; and the DeLong Corp., New York. Engineering for the sludge outfall was handled by Hyperion Engineers, a joint venture of Los Angeles firms—Daniel, Mann, Johnson & Mendenhall; Holmes & Narver; and Koebig & Koebig.

Contract for Effluent Outfall

This June the Los Angeles Board of Public Works awarded a $20,297,530 contract for construction of an effluent outfall, which will also be seven miles long. The new contract represents the low bid submitted by a six-company joint venture, sponsored by the Raymond Concrete Pile Co., of New York, and known as Hyperion Constructors. The other companies in the joint venture are the DeLong Corp.; the Healy Tibbitts Construction Co.; the Macco Corp., Paramount, Calif.; Peter Kiewit Sons Co., Omaha; and the Tavares Construction Co., La Jolla, Calif. Hyperion Engineers are the engineers for this project, too.

The contractors have 1,000 days to complete the effluent outfall, which will discharge waste water from the Hyperion Treatment Plant five miles into the Pacific. The contract includes the placing of 27,500 ft of 12-ft-dia concrete pipe in water up to 190 ft deep. The line will then be split into diffuser sections, each leg of which will contain 2,400 ft of 8 ½-ft-dia pipe and an additional 1,560 ft of 6-ft-dia pipe.

The Hyperion Treatment Project is part of a $60,000,000 sewerage system expansion designed to meet the requirements of the rapidly growing Los Angeles area. It will be the subject of an article scheduled for an early issue.

In this construction view of the ocean-outfall sludge line, taken from the end of the pier, cathodic-protection cable banded to the pier is visible. Control tower and Hyperion Treatment Plant in background.

Experimental Prestressed Concrete Highway Is Laid

An experimental stretch of prestressed concrete highway—recently completed at Pittsburgh, Pa., by the Jones & Laughlin Steel Corporation—represents one of the first full-scale efforts on the part of private industry to aid in carrying out the nation's huge highway construction program. The prestressed stretch consists of a 400-ft section, plus two 100-ft prestressed end sections. Extensive tests will be made on this roadway, which is situated on a 742-acre site adjacent to the company's Graham Laboratory.

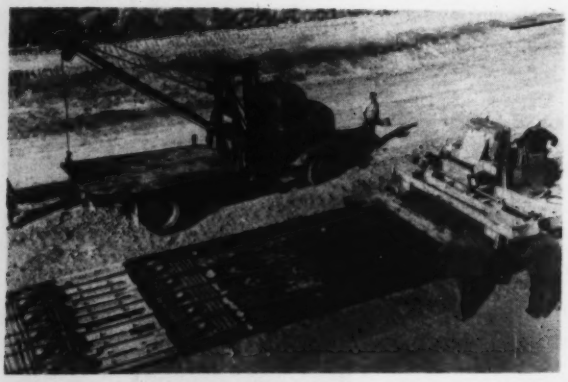
While the advantages of prestressed concrete are well known by now, the technique of prestressing concrete for highway use has been relatively unexplored in this country. It is generally conceded that prestressed concrete highways would have many advantages over conventional concrete roads. The problem has been to find a practical and economical method of building them.

Essentially the experiment consisted of anchoring connecting wire strands at opposite ends of a 400-ft section of concrete roadway slab. The strands were passed through flexible steel conduits embedded in the concrete. When the concrete for the 400-ft section was poured, a 6-ft gap was left in the middle. After the concrete had set, the gap was stretched apart with hydraulic jacks to a width of 8 ft—far enough to produce the required tension in the wire strands and consequent compression in the concrete. The jacks were then removed—a special device was developed to hold the sections apart during the process—and concrete was poured into the gap. The concrete slab is only 5 in. thick, half average pavement thickness.

Only one transverse joint was built into the 400-ft prestressed concrete section, in contrast to usual practice that calls for transverse joints at a maximum spacing of about 60 ft.

The idea for the experimental roadway was suggested by Admiral Ben Moreell, Hon. M. ASCE and chairman of the board of Jones & Laughlin. Engineering work on the project was handled by the Pittsburgh consulting firm of Richardson, Gordon & Associates, and the construction work by Allegheny Contracting Industries, Inc., of Pittsburgh. Test specimens were studied at Carnegie Institute of Technology under the direction of Charles F. Peck, A.M. ASCE. The testing instrumentation was designed by the Fritz Laboratory at Lehigh University under the direction of Prof. W. J. Eney, M. ASCE.

In this over-all view of the experimental roadway, concrete is being poured for the main 400-ft slab. Six "tendons," consisting of wire strands encased in flexible conduit, are visible on the roadbed. They are anchored in the concrete at both ends. Center of photo shows where the two sections of the main slab will be jacked apart in the prestressing operation.



This photo shows the gap left in the center of the roadway when the concrete was poured. Jacks were placed in the gap and the two sections spread apart to a width of 8 ft to produce the prestressing.

AEC Provides Access to Information

Information sufficient for industry to design, construct, and operate civilian power reactors and their related processing plants is being declassified rapidly by the Atomic Energy Commission. At the same time AEC is retaining classification on information of significance to the military security of the United States.

However, persons interested in the civilian application of atomic energy for peaceful purposes may obtain clearances enabling them to have access to classified documents under an access-permit program. As of December 1, 1956, 1,145 individuals, firms, institutions and organizations have obtained access permits, and about half of these have been granted facility clearances to possess classified technical information.

To aid those who have clearances, AEC has set up a Technical Information Service Extention which will help permit holders in locating and using fully the desired information from the wealth of documents and books available. A recent publication, "Guide to Atomic Energy Literature for Civilian Application Program," identified as TID-4575, can be obtained from the Technical Information Service of the AEC, Washington, D. C.

Do You Know Russian?

The Pergamon Institute—a non-profit foundation with headquarters in New York and London—is seeking engineers with knowledge of Russian to become members of its panel of paid translators. The foundation was formed recently for the purpose of making Russian technical and scientific publications more readily available to English-speaking engineers and scientists in the United Nations member countries.

According to the Institute, over 14-000 scientific and technical books were published in Russian in 1954, and there are currently at least a thousand scientific and technical periodicals in that language. However, only about 2 percent of our working scientists and engineers can read Russian, compared with the 80 to 90 percent who read French and the 60 percent who read German.

Interested and qualified translators should get in touch with Capt. I. R. Maxwell, Director of the Pergamon Institute, 4-5 Fitzroy Square, London, W. 1, England.

New Building for The State Department

A $35,424,200 low-bid contract for construction of the new State Department Building in Washington, D. C., has been awarded to John McShain, Inc., a Philadelphia construction firm. The contract, announced by the General Services Administration, calls for completion of the building within three years.

The new structure, together with the present State Department Building with which it will be integrated, will provide about 2,500,000 sq ft of floor area and will house in a single unit the Department's offices now scattered all over the city. Occupying the four square blocks bounded by 21st, 23rd, C and E Streets, N.W., it will be the largest federal building except for the Pentagon.

Deadline for Papers for Applied Mechanics Congress

Research workers in the field of applied mechanics are invited to submit papers detailing original experimental or theoretical contributions to the field for the third U. S. National Congress on Applied Mechanics, to be held at Brown University, Providence, R. I. June 11-14, 1958. Suggested topics include the mechanics of rigid bodies and deformable solids, mechanics of fluids and gases, thermodynamics, and heat transfer. The deadline for papers is January 1, 1958. However, authors are urged to submit their papers well in advance of this date to avoid overburdening the reviewers.

Inquiries about papers may be addressed to Prof. R. M. Haythornthwaite, A.M. ASCE, Chairman, Editorial Committee, Box D, Brown University, Providence 12, R. I. Inquiries about the congress should go to Prof. Daniel C. Drucker, Secretary of the Congress, at Brown University.

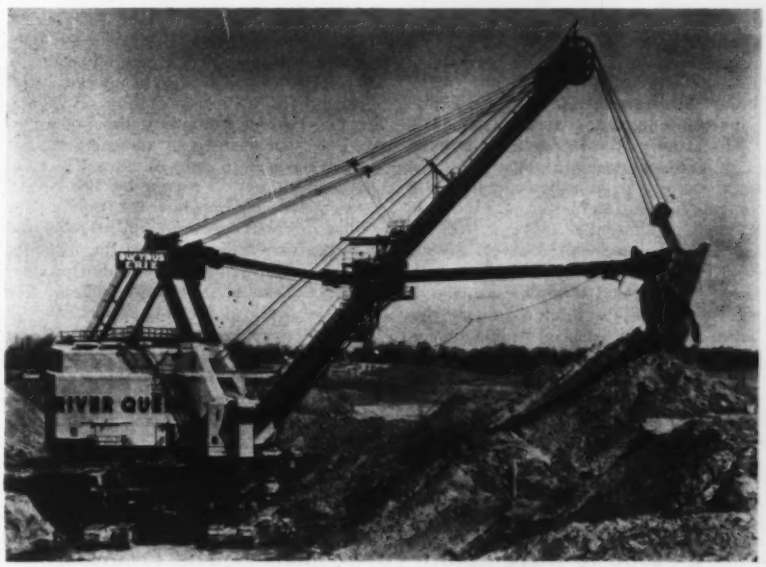
India Receives Grant For Training Engineers

A recent Ford Foundation grant of $1,500,000 will enable the Government of India to train 200 of its engineers in the management and production methods of the United States steel industry. The training, which is to begin in September and take a year, will be conducted by the nation's eight largest steel companies. Academic instruction will be provided by cooperating technological institutes in the vicinity of plants to which the trainees are assigned. Carnegie Institute of Technology will serve as administrator of the program in this country and as liaison between the educational institutions and the steel companies.

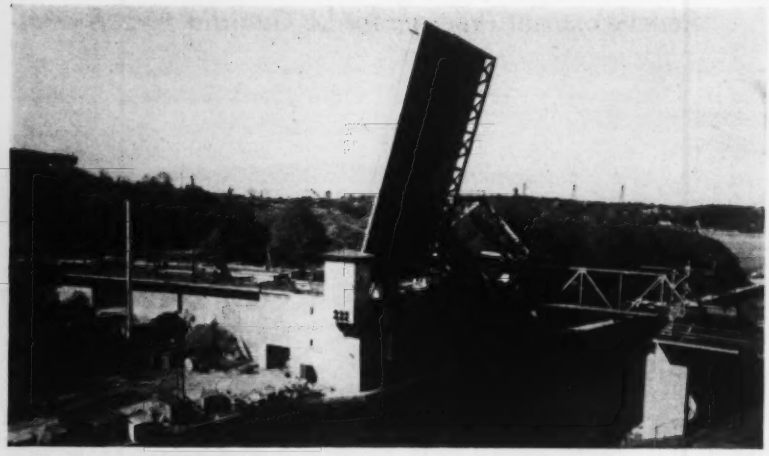
Redevelopment Program for La Guardia Airport

This is artist's rendering of $15,300,000 passenger terminal building, to be built at La Guardia Airport as part of the Port of New York Authority's recently announced $32,000,000 redevelopment program. This new 1,100-ft-long terminal building will provide 330,000 sq ft of space, more than three times existing passenger facilities. Under the redevelopment program public parking facilities will be increased by about 50 percent; the vehicular roadway system will be redesigned and rebuilt; and a number of runways, taxiways, and aprons and the entire utility system will be rehabilitated. Six airlines are cooperating with the Port Authority in the much needed redevelopment program.

Giant Shovel Speeds Coal-Stripping Work



Four levers control this 55-cu yd giant coal stripper that weighs 2,400 tons and has a 145-ft boom. High strength T-1 and Tri-Ten alloys from U.S. Steel Corp. are incorporated in the huge Bucyrus Erie shovel. Power comes from two 1,500-hp motor generators. The shovel moves on four independently driven crawler-type trucks, each weighing 218 tons. The big Bucyrus Erie 1650B can move 100,000 tons of material in a 24-hour day. Its maximum reach from digging to stacking is about 300 ft. The shovel is working in the River Queen open-pit mine near Central City in western Kentucky, where it will uncover two million tons of coal annually.



The Danviksbron Bridge at Stockholm, built at a cost of $1,500,000, is said to have the largest area of any single-leaf bascule.

Big Single-Leaf Bascule Bridge in Stockholm

Holger Lundbergh

A new link in the system of bridges encircling Stockholm has been opened. Connecting the southern part of the city with the east-coast districts across the shipping canal of Hammarbyleden, the Danviksbron Bridge is said to be the largest bascule bridge in the world of single-leaf type, reckoned in terms of area. The bascule leaf is 138 ft 6 in. long with a total width of 73 ft. Provision is made for widening it to 89 ft when an existing bridge that carries rail and east-bound pedestrian and motor traffic, is removed.

The Danviksbron Bridge has a number of interesting technical features. The counterweight is entirely concealed in a concrete foundation blasted into the rock, permitting unusually pleasant esthetic aspects for a bridge of its type. Special security measures include "accident-proof" railings and a warning-signal system with absolute interdependence between the three pairs of traffic booms, the traffic lights, and the electric hoisting and lowering machinery. Ships entering the canal are automatically warned off unless the bridge is hoisted at the required angle. Clearance above water, with the bridge in down position, is about 41 ft.

The bridge deck is zinc-treated steel grating filled with asphalt mastic and has a rolled-in surface of coarse gravel. It is skid resistant and requires practically no maintenance. Its weight remains constant, even when the humidity varies, thus obviating the necessity for any special adjustment of the counterweight.

Normally the bridge is opened in 80 seconds by an electric motor. However, a direct-coupled stand-by diesel-operated engine can be used in an emergency to open the span in eight minutes. The electric machinery is driven by two rotary converters of the Leonard type. With this, the hoisting speed can be regulated within very wide limits, so that the leaf can descend quietly and without producing percussions. Hydraulic buffers take up the shock at the stop face.

The structure was designed by the Stockholm Port Authority. The steel contractor was A. B. Motala Verkstad, with A. B. Broderna Hedlund fabricating the steel and the ASEA handling the electrical work.

Chicago to Have Record Public Improvement Program

Chicago and Cook County voters have approved a record-breaking $207,000,000 public works program to be carried out in the next three years. Schools, with an appropriation of $50,000,000, will have top priority in the new program. The aim is to provide 35,000 new classroom seats to match enrollment increases of about 15,000 a year. Other major projects in the new program include new sewers to serve an estimated population of 1,000,000, for which $8,000,000 has been earmarked; new bridges receiving $15,000,000; better street lighting, $15,000,000; airport improvement, $15,000,000; conservation work and slum clearance, $20,000,000; park improvement, $15,000,000.

Also in the cards for Chicago is a long-range project for consolidating the city's four major rail terminals at a single South Side site that has not yet been designated. The consolidation plan, which has been under consideration off and on since 1909, was recently authorized by the state senate. The four stations affected are the Illinois Central, Dearborn, La Salle, and New York Central, which currently handle nineteen separate passenger and freight lines. The project is to be financed in part by the sale of from 50 to 100 acres of valuable land that will become available when the consolidation is carried out.

Panama Receives Loan for Inter-American Highway

The Export-Import Bank of Washington has made a loan of $12,850,000 to the Republic of Panama to assist it in completing its share of five sections of the Inter-American Highway totaling 200 miles. Panama has already completed 96 miles of its share. Other recent Export-Import Bank loans to accelerate progress on the highway have been made to Costa Rica, Nicaragua, and Honduras.

The Central American portion of the 1,590 mile Inter-American Highway is being built by United States grants for two-thirds of the cost, with each country paying one-third of the total.

Research Program Combats Marine Boring Organisms

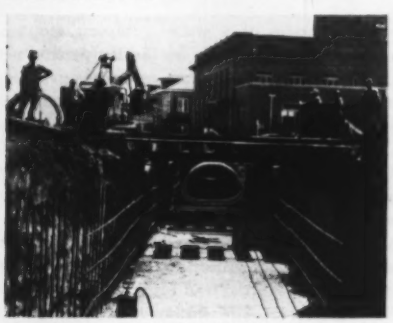
Technicians at U. S. Steel Corporation's new Research Center at Monroeville, Pa., study enlarged models of Limnoria, a wood-destructive crustacean. The models are being used in an intensive research program to aid in understanding marine boring organisms and to develop coal-chemical wood preservatives to combat them. Annual loss from marine boring organisms in United States waters is placed at over $50,000,000.

Constructing special section of storm sewer in downtown Hutchinson. A total of 225 precast rectangular units (10′ x 8′ x 2¾′) were used, each weighing 9 tons. Note units on left ready for placement.

LEHIGH EARLY STRENGTH CEMENT

speeds storm sewer project . . .

Placing unit on concrete base. Hole in side permits tie-in of feeder line.



Quartzite Stone Co., Lincoln, Kansas, manufactured arched and round pipe used in all other sections of system.

To meet unusual excavation requirements, specially designed rectangular precast concrete units were used for a 2250 ft. section of the new Hutchinson, Kansas, storm sewer system.

Using Lehigh Early Strength Cement, the contractor cast units one day, stripped forms the next. Form, curing and general overhead costs were cut, and units were moved to jobsite in half the time required had regular portland cement been used.

Lehigh Early Strength Cement was also used in parts of the cast-in-place base for the pipe and in resurfacing street intersections, to keep the entire job moving smoothly, to cut down annoying detours.

This is another example that gives us reason to say "Somewhere on nearly every job Lehigh Early Strength Cement will save time and money."

Contractor: J. H. Shears Sons, Inc., Hutchinson, Kansas

Engineer: Ray Bruggeman, City Engineer, Hutchinson, Kansas

Ready Mixed Concrete: Shears Ready Mix Concrete Co., Hutchinson, Kansas

• LEHIGH EARLY STRENGTH CEMENT • LEHIGH PORTLAND CEMENT
• LEHIGH MORTAR CEMENT • LEHIGH AIR-ENTRAINING CEMENT

LEHIGH PORTLAND CEMENT COMPANY
Allentown, Pa.

Method for Photogrammetric Map Checking

Robert S. Brandt, Chief Photogrammetrist, and Harvey F. Ludwig, M.ASCE, Civil Engineer,

Hycon Aerial Surveys, Pasadena, Calif.

Users of maps produced by photogrammetric methods have long felt the need for a method of checking the accuracy or reliability of a map without having to resort to check measurements made directly in the field. Such measurements made directly in the field are a valid check simply because they represent a measurement independent of that given by the photogrammetric map. However, the stereo-compilation process itself, as it is used in photogrammetric map making, affords numerous opportunities for independent measurements, depending upon the degree of redundancy available in establishing a model or in the areas common to adjacent models. Hycon has developed what might be termed a built-in checking method, in which the stereo-compiler, as an extra step, records redundant data in a systematic fashion. Statistical analysis of these data, carried out independently of the map compilation, affords valid indication of the accuracy or reliability of the map in total or by sections.

Classical error theory assumes that normally a measurement process produces several sources of error which make the result more or less inexact. In topographic photogrammetry, as in any measuring system, the measuring errors and their contribution to the final results are the factors that determine the accuracy of the map. Any method for determining the precision of measurement and its total effect on the final map will involve an application of the theory of errors.

A usual application of error theory is to arrange the measurements so that more observations are obtained than are needed for solution of the measuring problem. In normal map production, numerous measurement differences occur through measuring errors. From these differences it is possible to find the most probable value of the measurements and their reliability, which can be expressed in a well defined and theoretically correct way.

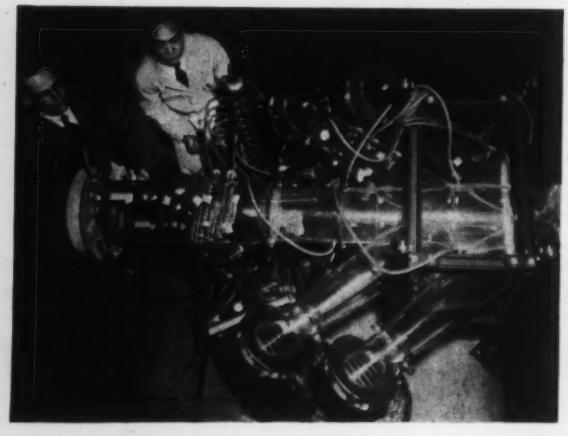
In order to apply the theory of errors to the photogrammetric process so as to achieve checking information independent of the map compilation, two requirements must be met: (1) redundant measurements must be possible in each of the unit areas ("model areas"), which together make the map, and (2) such redundant measurements must be recorded in a form suitable for subsequent statistical least-square analysis.

In the usual compilation process, redundancy within a model area may be available from one source and is always available from a second. The first type of redundancy will exist if there are more than three ground-control points in the model area. Each additional point over three enables a new set-up and hence permits a set of independent measurements throughout the model area. The second source of redundancy stems from the overlap between adjacent models, which commonly is about 20 percent. The two model set-ups present in effect two independent maps of this common area. In the usual compilation process, of course, the operator is aware of these redundancies, but by manual manipulation he *averages* them to obtain the best possible fit so far as visual inspection and his judgment permit, and he makes no record of the extent of the differences. He knows, of course, whether these differences are large or small and, on the basis of his observation, he develops a "feel" for the quality of the map by sections and by total.

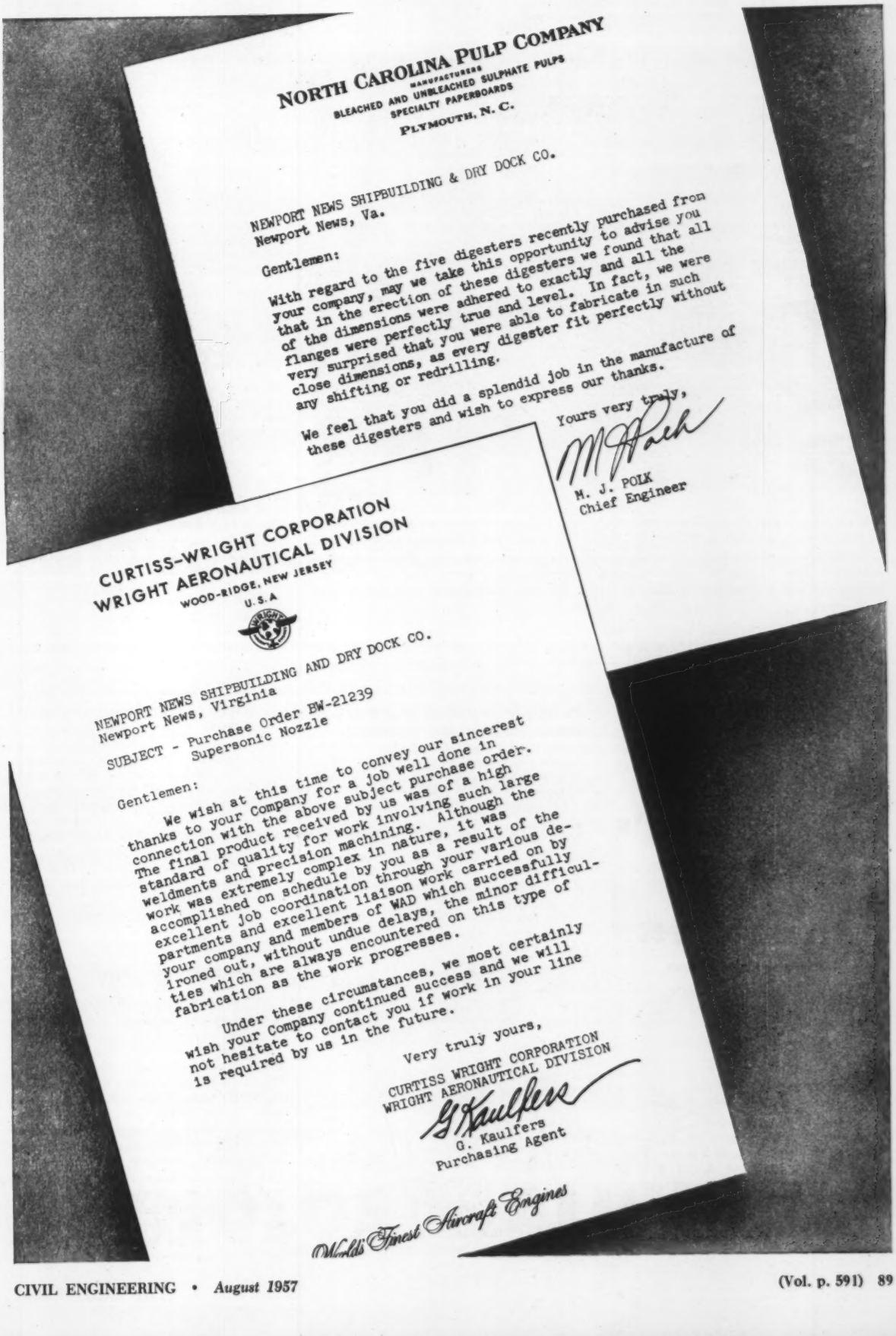
The Hycon method provides for systematic recording of whatever redundant data are available. One such method is as follows: (1) for each model the operator selects a number of identifiable points (say 10) spaced throughout the edge sections of the area which will be common to adjacent set-ups, and (2) for these points he records the X, Y, and Z coordinates for each possible set-up of that area (depending on the extent of ground control—if four points are available he makes two set-ups, etc.). These data are then subjected to statistical analysis (employing an automatic digital computer) to determine the most probable value of the coordinates, the magnitude of the variations in the individual measurements, and the probable accuracy (reliability) of the entire model area for use in making horizontal and vertical distance measurements. Further statistical computations likewise give reliability information applicable to the map as a whole.

The cost of this extra service will generally be of the magnitude of an additional 10 to 15 percent of the normal cost for a topographic mapping job.

Turbulence Studies to Reduce Detroit Water Costs



This all-acrylic model of a water-pumping station, used in turbulence studies being made by the University of Michigan civil engineering department, has already saved the City of Detroit over $100,000 on its new $6,000,000 underground pumping station which will be started soon. Some 46 design changes were tried out directly on the model, which consists essentially of confetti blown through transparent plastic tubing to simulate water flow. Tubing and fabrication of the model are by the Cadillac Plastic and Chemical Co. The model study of proposed designs is conducted by Prof. Victor L. Streeter, M. ASCE, consultant to the Ann Arbor engineering firm of Ayres, Lewis, Norris, and May, which holds the design contract for the project. The station is scheduled to deliver a billion gallons of water daily by 1970, more than double the city's present supply.



NORTH CAROLINA PULP COMPANY
MANUFACTURERS
BLEACHED AND UNBLEACHED SULPHATE PULPS
SPECIALTY PAPERBOARDS
PLYMOUTH, N. C.

NEWPORT NEWS SHIPBUILDING & DRY DOCK CO.
Newport News, Va.

Gentlemen:

With regard to the five digesters recently purchased from your company, may we take this opportunity to advise you that in the erection of these digesters we found that all of the dimensions were adhered to exactly and all the flanges were perfectly true and level. In fact, we were very surprised that you were able to fabricate in such close dimensions, as every digester fit perfectly without any shifting or redrilling.

We feel that you did a splendid job in the manufacture of these digesters and wish to express our thanks.

Yours very truly,

M. J. POLK
Chief Engineer

CURTISS-WRIGHT CORPORATION
WRIGHT AERONAUTICAL DIVISION
WOOD-RIDGE, NEW JERSEY
U. S. A

NEWPORT NEWS SHIPBUILDING AND DRY DOCK CO.
Newport News, Virginia

SUBJECT - Purchase Order EW-21239
Supersonic Nozzle

Gentlemen:

We wish at this time to convey our sincerest thanks to your Company for a job well done in connection with the above subject purchase order. The final product received by us was of a high standard of quality for work involving such large weldments and precision machining. Although the work was extremely complex in nature, it was accomplished on schedule by you as a result of the excellent job coordination through your various departments and excellent liaison work carried on by your company and members of WAD which successfully ironed out, without undue delays, the minor difficulties which are always encountered on this type of fabrication as the work progresses.

Under these circumstances, we most certainly wish your Company continued success and we will not hesitate to contact you if work in your line is required by us in the future.

Very truly yours,

CURTISS WRIGHT CORPORATION
WRIGHT AERONAUTICAL DIVISION

G. Kaulfers
Purchasing Agent

World's Finest Aircraft Engines

Shoring System Speeds Work on Chicago Office Building

Tubular steel scaffold saves time, materials, and labor as support for concrete slabs on Chicago office building. Sherman Olson, Inc., is using the Advance scaffold on a six-story reinforced concrete building for the Morton Salt Company. Shoring system consists of 6½-, 5-, and 4-ft scaffold panels with accessory items. The slab is 9 in., but the scaffold will support a much greater load. This view shows a portion of one slab area.

Near's N. G. COLUMN

R. Robinson Rowe, M. ASCE

"I found all four answers," bragged Joe Kerr.

"All *four?*" asked the Professor.

"Check. I was to find X in the 11-digit number NOPQRSTUVWX, given that it and NOPQRSTUVW were perfect squares. Now, no squares end in 2, 3, 7 or 8, nor in an odd number of 0's, so these are out. Squares ending in 5 end in 25, but W can't be 2, so 5 is out. That leaves me four answers: X = 1, 4, 6 or 9."

"Yes," nodded Cal Klater, "but which fits the 11-digit square?"

"Any one," persisted Joe. "It was your problem to find the other 10 digits, but I'll tip you off that my answer to your problem for X = 1 was 00000000361."

"Smarty!" raged Cal. "That's only a 3-digit number, and you know it. The real problem is to solve the pellian equation

$$A^2 - 10B^2 = X. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

which has an infinite number of solutions, to find the one that has exactly 11 digits in A^2. Now if we have one solution, such as Joe's A = 19, B = 6, X = 1, and we compute C and D from the 'generators'

$$C = 19A + 60B \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2a)$$

$$D = 6A + 19B \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2b)$$

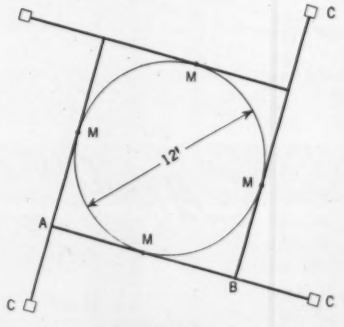


Fig. 1. The pinwheel frame lifts itself by its bootstraps.

Then $C^2 - 10D^2 = X$, giving a new solution, in this case, $C^2 = 519841$.

"I started with the 7 'primitive' solutions: $C^2 = 01, 04, 09, 16, 49, 169$ and 256 and generated 7 more: $C^2 = 361, 1444, 3249, 18496, 64009, 237169$ and 364816. Using the generators on these, and repeating, the next 12 were:

519841	526060096
2079364	749609641
4678569	2998438564
26666896	6746486769
92294449	38453641216*
341991049	133088524969

The only one with 11 digits is marked with an asterisk, so Joe's answer should have been X = 6, and mine is 3845364121 (= 62011^2)."

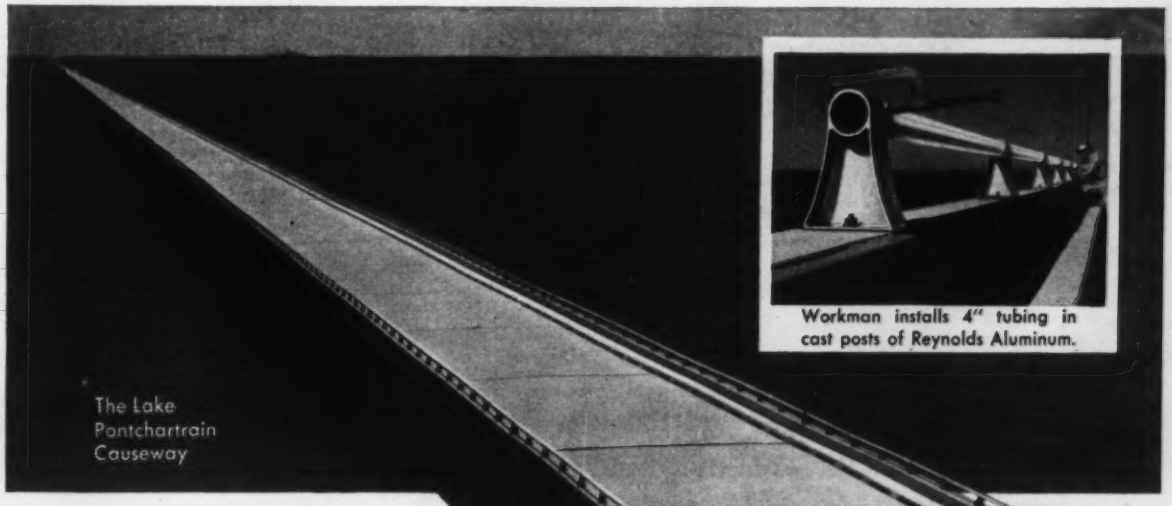
"So very correct!" exclaimed the Professor. "And, Cal, I'm glad you listed all those solutions to Eq. 1, for, if you look carefully, you'll find at least two for each number of digits from one to ten. I had to ask for an 11-digit number to define unique answers for both you and Joe. With 14 digits, Joe's answer would still be 6 and yours would have been 5,545,012,396,225. With 15 digits, you would have two solutions, both ending in 9 for Joe.

"If you've never been introduced to the pinwheel frame, you'll tackle our new problem like a kitten chasing its own tail. The frame in Fig. 1 consists of four beams like AC, supported by a column at C and simply joined to analogous beams at A and B. Neglecting the weights of the beams, the only load is a cylindrical tank 12 ft in diameter supported by the beams at points M. When the connection at C is also simple, the maximum moment in the beam AC is 252 k-ft, but when the connection is rigid to an inflexible column, the maximum moment is only 163. How much does this rigid connection reduce maximum vertical shear?"

[*Cal Klater's answer was checked by 7 different methods by Richard Jenney, Jesse P. Walton, S. K. Rueball (Keith Jones and W. R. Wright), Ed C. Holt, Jr., Rudolph W. Meyer, Al Gorithm (L. E. Goodman), and Ad L. Pate (G. H. Wilsey).*]

Steelmaking in April

During April the steelmaking furnaces of the nation produced 9,814,000 tons of ingots and steel for castings, according to the American Iron and Steel Institute. This output brought the total for the first four months of the year to 41,399,042 tons, which is about a million tons below production for the comparable period of last year. The April production figure compared with 10,589,074 tons produced in March and with the April 1956 output of 10,523,785 tons. Steelmaking furnaces in April were operated at 89.5 percent of capacity, and the average operating rate for the first four months of the year was 94.4 percent of capacity.



Workman installs 4" tubing in cast posts of Reynolds Aluminum.

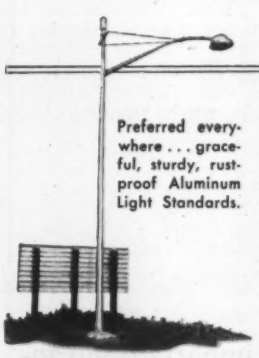
WORLD'S LONGEST HIGHWAY BRIDGE...

ALUMINUM BRIDGE RAILING

This bridge, 23.83 miles long, was completed nearly four months ahead of schedule—a triumph of modern methods and materials. It features Aluminum Bridge Railing—nearly 48 miles of it, with over 31,000 cast posts of Reynolds Aluminum. Rustproof and corrosion-resistant, this railing will never need paint—assuring lowest maintenance cost. And note how aluminum's clean, modern look adds to the Causeway's simple, functional beauty!

Cast posts and railing extrusions are available in many designs. Call the nearest Reynolds Sales Office. For Reynolds authoritative 52-page book "Bridge Railings", write **Reynolds Metals Company,** General Sales Office, Louisville 1, Kentucky.

The Finest Products Made with Aluminum are made with REYNOLDS ALUMINUM



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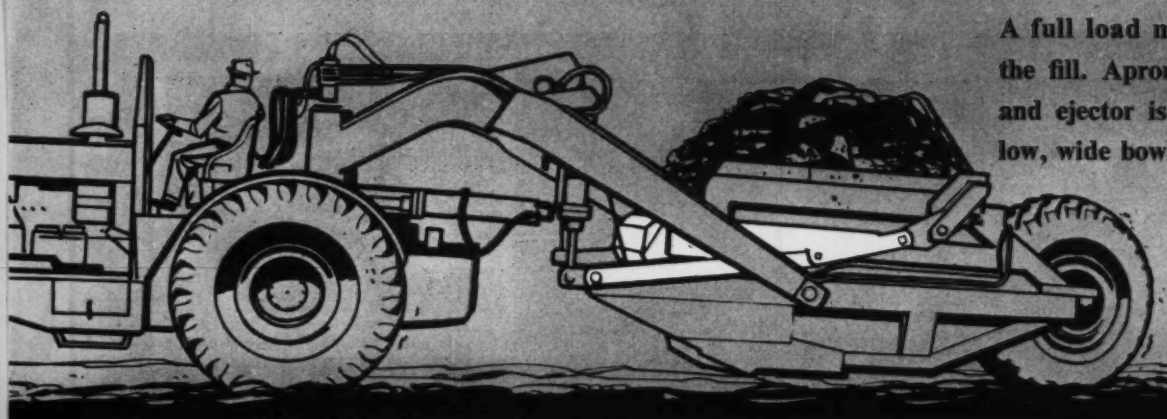
Many shapes and sizes in Reynolds Aluminum Sign Blanks—never rust.

Aluminum Chain Link Fencing...strong, beautiful...needs no paint.

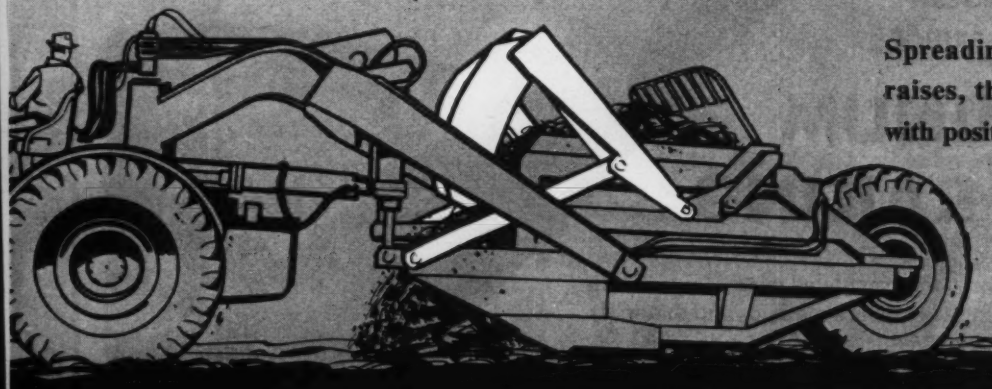
REYNOLDS ALUMINUM

Watch "CIRCUS BOY", Reynolds dramatic adventure series, Sundays, NBC-TV.



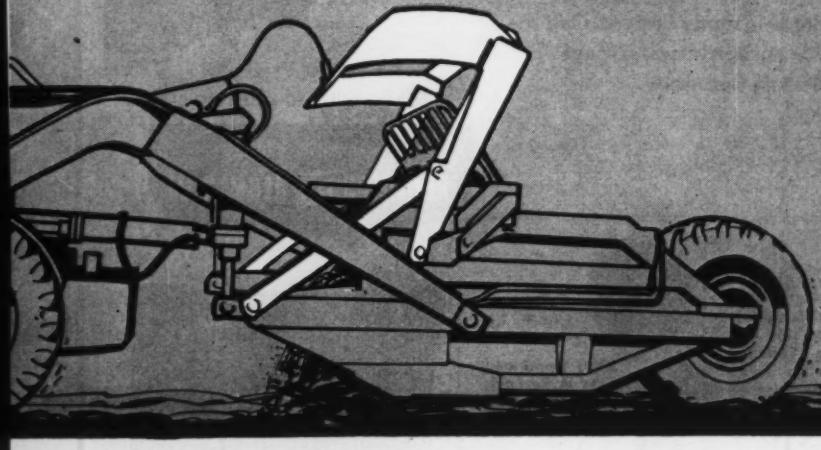
A full load moves on to the fill. Apron is closed, and ejector is at rear of low, wide bowl.

How Allis-Chalmers' patented 3-point scraper linkage



Spreading starts. As the apron raises, the ejector moves forward with positive force, accurate control.

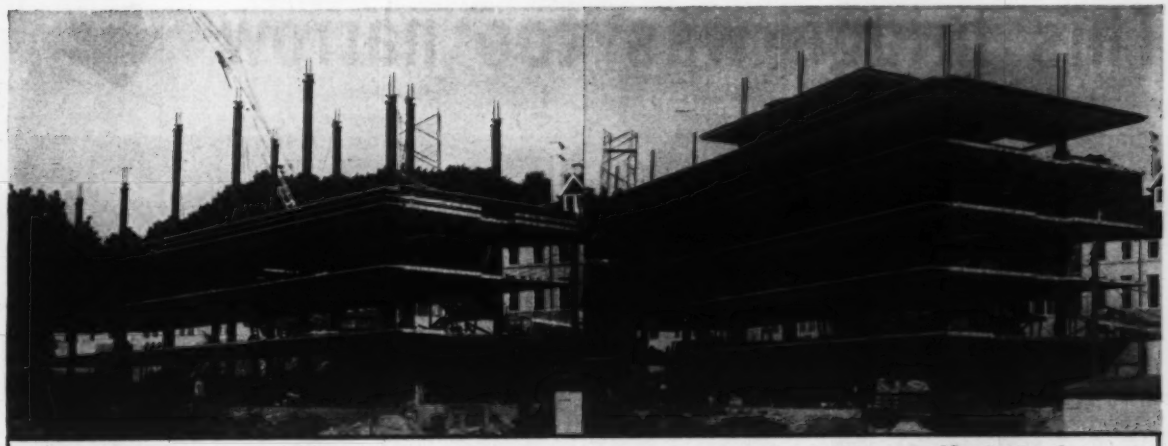
assures fast, clean, controlled spreading of any material

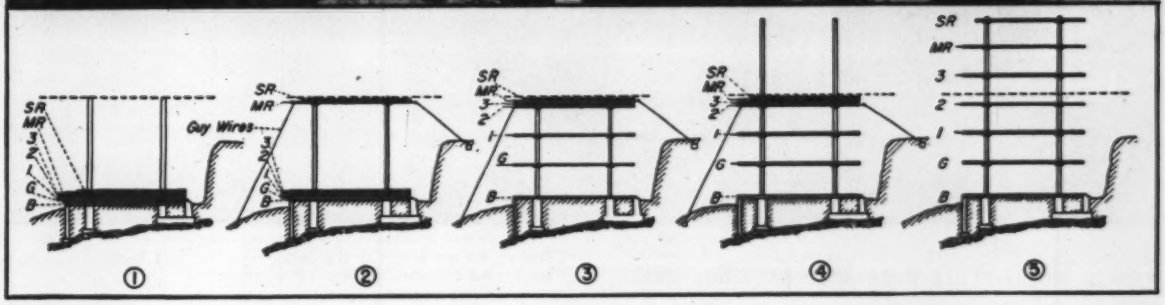


As ejector moves toward cutting edge, linkage simultaneously moves apron forward and upward, providing opening large enough to let any load fall free without jamming. Result: faster cycles, higher production, more profit!

Only your nearby Allis-Chalmers dealer can offer you this important advantage. See it demonstrated now . . . on either motor or pull-type scrapers. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS *Engineering in Action*





Why They Used PLASTIMENT in this 6-Story Prestressed Lift-Slab

Combining two recent construction and design techniques – lift slab and prestressing – the Litchfield County Hospital at Winsted, Connecticut is an outstanding example of advanced engineering.

Concrete of uniform high quality was essential to the success of the project. According to the engineer:

"Plastiment was added to the concrete to reduce the amount of water and shrinkage and to improve workability."

Plastiment has been selected by engineers for many outstanding projects because of its proved ability to increase concrete uniformity and strength, improve placeability at low slump, and reduce cracking.

Let Plastiment work for you. Write or call today for information.

Structural Engineer – Marchant and Minges – West Hartford, Connecticut
Architects – Sherwood, Mills & Smith – Stamford, Connecticut
General Contractor – A. F. Peaslee, Inc. – Hartford, Connecticut
Lift Slab Contractor – New England Lift Slab Corp. – Hingman, Massachusetts
Prestressing Consultants – Freyssinet, Inc. – New York, N. Y.

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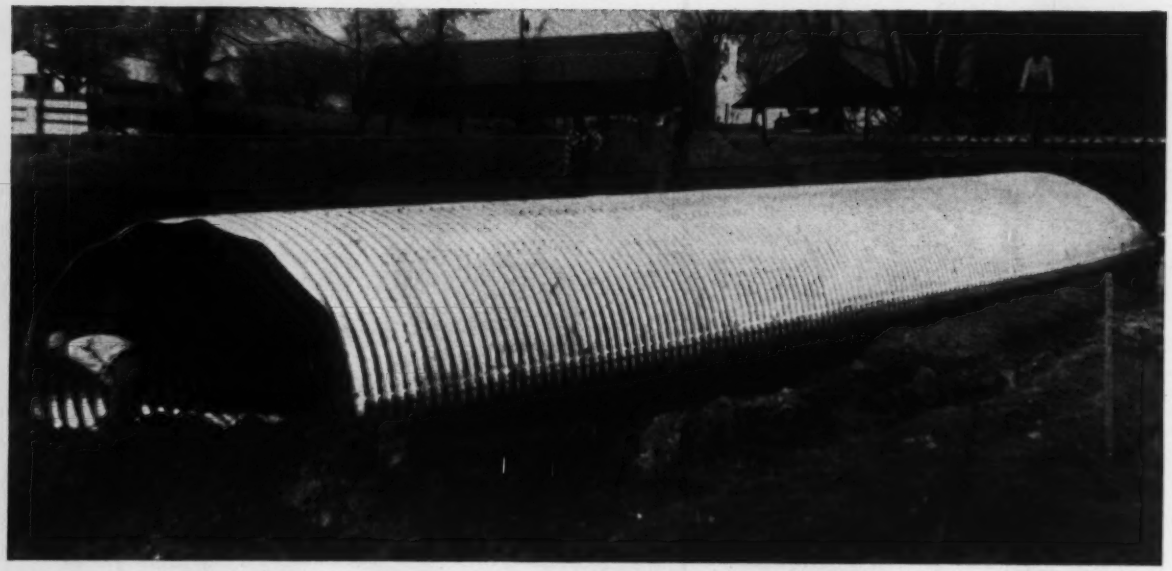
This bridge was too narrow



The old narrow bridge in the background remained in service while a small crew installed the MULTI-PLATE Structure.

Armco MULTI-PLATE Pipe-Arch provides quick, economical replacement

This old bridge in Champaign County, Ohio, was typical of many structures that are inadequate for today's traffic demands. It was too narrow and required frequent maintenance.

So the county replaced it with an Armco MULTI-PLATE® Pipe-Arch. The old bridge remained in service while the Armco Structure was installed. A low, wide-bottomed Pipe-Arch was selected to meet the headroom requirements. Earth backfill made it just like building the new pavement on solid ground. Now there is no worry about load limitations and practically nothing to maintain.

MULTI-PLATE is only one of many Armco products for drainage and construction work. Others include Corrugated Metal Pipe, FLEX-BEAM® Guardrail, Perforated Subdrainage Pipe, Retaining Walls, Steel Buildings, Pipe Piling, and Tunnel Liner. Write us for complete details. Armco Drainage & Metal Products, Inc., 5397 Curtis St., Middletown, Ohio. Subsidiary of Armco Steel Corporation. In Canada: write Guelph, Ontario. Export: The Armco International Corporation.

With the roadway placed on earth fill, motorists are scarcely aware that they are crossing a stream. Note the Armco FLEX-BEAM Guardrail installed on the roadway shoulder.

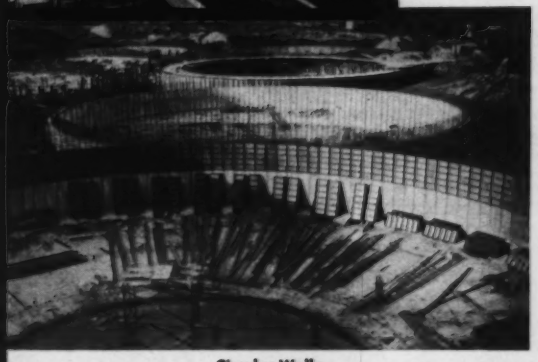
Armco Construction Products

reduce forming costs...

with UNI-FORM PANELS

Sewage Treatment Plant "Y" Walls

Slabs



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Heavy Industrial Foundations

Whether you're bidding on a sewage treatment plant, industrial building, highway bridges, overpasses or abutments, heavy foundations, circular tanks or a warehouse, UNI-FORM Panels will give you the lowest all around forming costs.

Why? UNI-FORM Panels can be erected faster, using less labor and material because the three basic elements of the UNI-FORM System—Panel, Tie and Tie Key provide simple mechanical assembly into any type of form. Unique system of attaching the minimum aligning lumber required reduces labor by 50% . . . pre-engineered techniques for handling pilasters, corners, stepped footings, columns, battered walls assure fast job progress.

Steel framed, plywood faced UNI-FORM Panel

UNI-FORM TIE for any wall width

UNI-FORM Tie Key

3 simple elements in UNI-FORM SYSTEM

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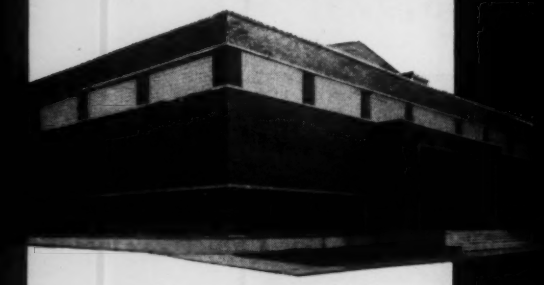

BLUFFTON HIGH SCHOOL GYMNASIUM

Architect: A. M. Strauss, Incorporated, Fort Wayne, Ind.

General Contractor: W. A. Sheets & Sons, Fort Wayne, Ind.

Structural Steel Fabricator: Art Iron & Wire Works, Inc., Toledo, Ohio.

The vast, postless interior of Bluffton High School Gymnasium at Bluffton, Indiana, gives every spectator a clear, unobstructed view of the playing area. The rigid frame steel construction offers strength, safety, economy of erection, and minimum maintenance—four considerations which are mandatory in present-day school building. Notice the ample amount of window area made possible by rigid frame construction.

WHY IT PAYS TO USE STRUCTURAL STEEL

No other common structural material is as *strong* as steel, as *practical* as steel, as *safe* as steel. But architects and engineers need no convincing. They specify structural steel every day for more and more schools, churches, and similar medium-sized structures—as well as for huge skyscrapers, bridges, and aircraft hangars. The versatility of structural steel is not limited by the size of the building. Look at some of these specific advantages of structural steel:

- It is the *strongest*, yet *most economical* of load-bearing materials.
- Structural steel will withstand more abuse than other structural materials, effectively resisting tension, torsion, compression and shear.
- Once enclosed in buildings, it requires no maintenance—lasts indefinitely.
- Structural steel may be riveted, bolted or welded . . . can be erected in any weather.
- Steel members are fabricated indoors, where weather can have no effect on the quality of the workmanship.

Clear-span construction with

Approximately 240 tons of USS Structural Steel were used in the construction of the gymnasium. The steel framework was erected in seven weeks—joining accomplished by bolting and welding. The total structure—masonry, floor, seats, fixtures, everything—was completed and ready for use in 12 months.

FOR BLUFFTON HIGH

USS STRUCTURAL STEEL keeps costs down

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Please send me a free copy of **Hot Rolled Carbon Steel Shapes and Plates**—a handbook containing detailing dimensions and weights of all USS Structural Steel.

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WILD
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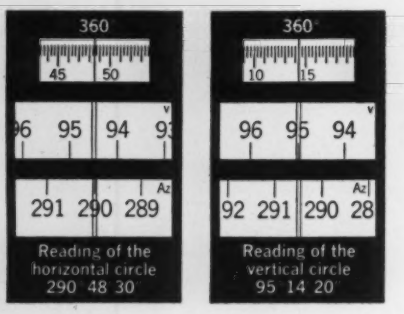
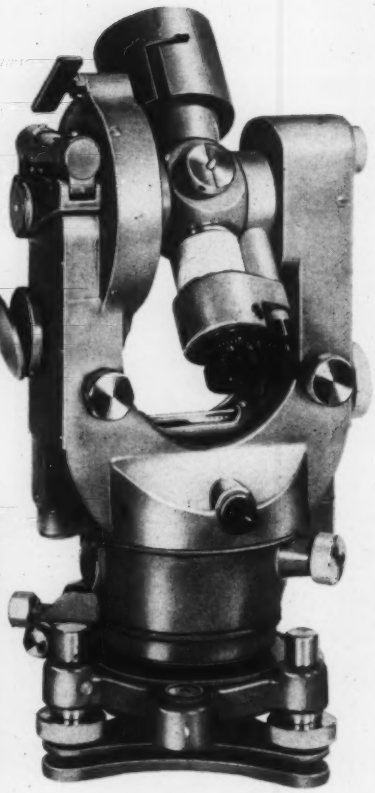
T-1 Optical Repeating Transit





By day or underground, this **WILD** *instrument offers unprecedented advantages*

From its optical excellence to its mechanical precision the T-1 has earned a world-wide reputation for great performance. Users everywhere praise the instrument for its rapid set-up, high accuracy and virtually unlimited versatility!

NOTABLE FEATURES OF THE WILD T-1

- **Reads direct to 20 seconds with interpolation to 10 seconds, on both horizontal and vertical scales.**
- **More than a dozen accessories are available for quick, simple, accurate solution of routine and special problems.**
- **Built-in illumination for both circles, scale and reticle.**
- **Rugged, precision construction throughout.**

PRICE: $718; F.O.B. Port Washington, N. Y. Tripods extra. Write for Booklet T-1.

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DECEASED

Stanley Urner Benscoter (A.M. '46), age 46, aeronautical engineer for the Aerophysics Development Corp., Santa Monica, Calif., died recently. He had been in the U.S. Engineer Office at Jacksonville, Fla.; Kansas City, Mo.; and more recently Vicksburg, Miss. Mr. Benscoter held B.S. and M.S. degrees from the University of Illinois.

Carlton T. Bishop (M. '23), age 74, associate professor emeritus of civil engineering at Yale University, New Haven, Conn., died at his home there on June 8. An alumnus of Yale, Professor Bishop taught at the university for 43 years. His many services to the university included the design of the famous Yale Bowl. He served on the New Haven Board of Park Commissioners for 17 years, and had been president for the past two years. He was also a consulting engineer for the local firm of Westcort & Mapes.

John P. Brooks (A.M. '96), age 95, president emeritus of Clarkson College, died at Eliot, Me., on June 16. Dr. Brooks was president of Clarkson from 1911 until his retirement in 1929. He had also taught at Lehigh University, the University of Kentucky, and the University of Illinois. He held B.S., M.S., and Sc.D. degrees from Dartmouth College.

Robert H. Brown (A.M. '10), age 79, sanitary engineer of Mineola, N. Y., died on April 6. Prior to his retirement Mr. Brown served as executive secretary to the Houston (Tex.) Anti-Tuberculosis League. Earlier he had been a lecturer in sanitary engineering and public health at Columbia University and had worked as sanitary engineer for Pacific Flush Tank Co., N. Y. and the Manhattan Bureau of Sewers. Mr. Brown was an alumnus of New York University and had done graduate work at Massachusetts Institute of Technology.

Harry W. Dennis, Former ASCE Officer, Dies

Harry Whiting Dennis (M. '14), age 78, former Vice-President and Director of ASCE, died recently in Los Angeles, Calif. In addition to his service as Society officer, he was secretary, vice-president and president of the Los Angeles Section. He served the War Department as a civilian consultant during World War II. Earlier in his career, Mr. Dennis had been chief civil engineer for the Southern California Edison Co. at Los Angeles responsible for the design and construction of the Long Beach No. 1 Steam Station and the Kern River No. 3 hydroelectric station.

H. W. Dennis

(Continued on page 100)

BETTER APPEARANCE is achieved with the help of Atlas Mortar Cement in new men's dormitories at Valparaiso University, Valparaiso, Ind. According to Masonry Foreman James S. Sedan, "This is the best mortar I have ever used —has remarkable workability and stays workable." Project architects: Hare & Hatch, New York; Contractor: Hagerman Construction Corp., Fort Wayne, Ind.

Modern masonry for modern design laid with ATLAS® MORTAR Cement

- Better mortar workability characteristics are the basis for better masonry.
- Field reports confirm that Atlas Mortar contributes to excellent workability, high yields, and weather-resistant masonry.
- Quality-controlled manufacture of Atlas Mortar promotes uniformly good performance and appearance. For further information, write Universal Atlas, 100 Park Avenue, New York 17, N.Y.

UNIVERSAL ATLAS CEMENTS

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Spillway Structure, Greater Chao Phya Project—Royal Irrigation Department

Servicised Rubber Waterstop and Self-Expanding Cork Joint Filler SOLVE the SAME PROBLEM

When engineers for two widely separated projects—the Spillway Structure of the Greater Chao Phya Dam in Thailand and the Torresdale Filter Plant in Philadelphia specified premolded expansion joint and waterstop, they chose Servicised Self-Expanding Cork Joint Filler and Dumbbell Type Rubber Waterstop for optimum performance under every condition.

Servicised Self-Expanding Cork is a "maximum performance" material that will keep joint spaces filled under contraction which opens the space to more than its original size. Specially treated to enable it to expand as much as 50% beyond original thickness, Servicised Self-Expanding Cork is fully compressible, non-extruding and resilient. It is widely used in water and sewage treatment plants, canal linings, outlet works, stilling basins of dams.

Servicised Dumbbell Type Rubber Waterstop provides superior characteristics of ultimate elongation, tensile strength and retention in the concrete during contraction to insure an effective seal of joints against water pressure. Available in 2 types—Hollow Bulb and Flat, in 6", 9" and 12" widths. New Union makes field splicing a fast, simple operation. Split Type Waterstop also available.

Servicised products for the construction industry are illustrated and described in the new Servicised Catalog. Write for your copy.

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Deceased

(Continued from page 98)

At one time he had a consulting practice in Los Angeles. His valuable contributions include service to the Engineering Foundation. Mr. Dennis was a graduate of Cornell University.

Daniel Keating Dotson (A.M. '56), age 40, office engineer for the Roberts Construction Company, Lincoln, Nebr., died of a heart attack at his home there on June 11. Earlier Mr. Dotson was for many years assistant engineer and construction management engineer for the Bureau of Reclamation, Denver, Colo., and Washington, D. C. He was a graduate of George Washington University and a veteran of World War II.

Ramesh Madanlal Engineer (J.M. '48), age 32, partner in the Madanlal T. Engineer & Co., consulting engineers of Bombay, India, died recently in Switzerland. Mr. Engineer received his B.S.C.E. degree from the University of Michigan, and his B.S. degree from the University of Bombay.

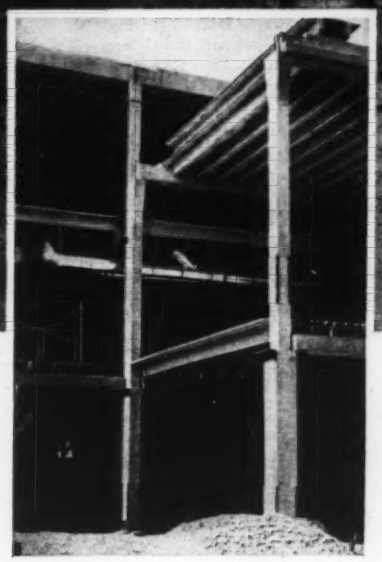
Chester Centennial Fisher (M. '19), age 80, retired irrigation engineer for the U. S. Bureau of Reclamation and a resident of San Diego, Calif., died there on June 13. Connected with the Bureau of Reclamation from 1903 until his retirement in 1946, Mr. Fisher had been resident engineer on irrigation projects in Arizona, New Mexico, Oregon, and Washington. He received his B.S. and C.E. degrees from the University of Oregon.

Lester R. Gifford (A.M. '02), age 84, president of Gifford and Company, engineers and manufacturers of St. Louis, Mo., died in May. He was formerly connected with the Stupp Brothers Bridge and Iron Company, the St. Louis Structural Steel Company, the Virginia Bridge Company, the Cambria Steel Company, and the O. K. Harry Steel Co., all of St. Louis. Mr. Gifford was the author of several PROCEEDINGS papers concerning the uses and properties of corrugated steel sheet piling. He was an 1895 graduate of Rensselaer Polytechnic Institute.

William Abbott Hazard (A.M. '09), age 84, since 1931 erection engineer for the Bethlehem Steel Co., Bethlehem, Pa., died in May. Joining the company in 1922, Mr. Hazard also served it as superintendent of erection and assistant engineer. Prior to his association there he was manager and chief engineer of the Lackawanna Bridge Co., Buffalo, N. Y. Mr. Hazard was an 1899 graduate of the Massachusetts Institute of Technology.

Lester C. Hammond (M. '20), age 76, retired consulting engineer of Fort Lauderdale, Fla., and former chief engineer of the Borough of Manhattan, died in Lakewood, Ohio, on June 11. During his 17 years in New York municipal service, Mr. Hammond was associated with

(Continued on page 102)



Allison-Erwin Warehouse and Office built with deflected strand precast prestressed concrete members fabricated and erected by Concrete Materials Incorporated, Charlotte, North Carolina. The seven-wire uncoated stress-relieved prestressed concrete strands were manufactured by Roebling.

Floor bays 27′ x 27′, prestressed girders and double tees have poured-in-place cover which forms composite section. Live load 200 lbs. per sq. ft.

Roof bays 27′ x 54′, prestressed girders and double tees. Live load 30 lbs. per sq. ft.

Erection was speeded by use of precast reinforced concrete columns.

Architect-Engineer—J. N. Pease & Company, Charlotte, N. C.
Contractor—Goods Construction Company, Charlotte, N. C.

NOW—INCREASED LOAD CAPACITY with PRECAST PRESTRESSED CONCRETE MEMBERS using DEFLECTED STRAND TECHNIQUE

Many successful applications in structures of virtually every description have proved the tremendous benefits of precast prestressed concrete members using straight strands.

Now architects and fabricators are finding that the deflected strand technique *further increases* the maximum span and load-carrying capacity of precast prestressed members. In fact, the only limitations of this method are casting-bed capacity and transportation facilities.

An additional advantage can be gained in multiple span structures by the use of continuity. This is achieved by placing ordinary reinforcing bars across the construction joints and pouring a small amount of concrete in place around these bars.

For data on tensioning elements and general information on prestressed concrete, write Construction Materials Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey.

Consult Roebling . . . First in U. S. with prestressing and tensioning elements.

ROEBLING

Branch Offices in Principal Cities
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Deceased

(Continued from page 100)

such notable projects as the design of the World's Fair. Earlier in his career he was resident engineer for the Panama Canal Commission and an executive for the Turner Construction Company. He had B.S. and C.E. degrees from Massachusetts Institute of Technology.

Harry Andrew Jansen (A.M. '51), age 40, since 1951 assistant civil engineer for the New York State Department of Public Works, Albany, died recently. Earlier, Mr. Jansen had been a junior civil engineer with the department at Troy, N. Y. He held the rank of captain in the Corps of Engineers during the war. He was a graduate of Rensselaer Polytechnic Institute.

Henry Delano Loring (M. '30), age 72, president of the Ferro Concrete Construction Co., Cincinnati, Ohio, died recently. Mr. Loring had been associated with Ferro since his graduation from Massachusetts Institute of Technology in 1907. He was also president of the Ferro Realty Company and the Ferro Hamilton Company. Mr. Loring was long active in the Engineering Society of Cincinnati.

Lorin Sloan MacDowell (A.M. '20), age 73, bridge design engineer for the Ohio State Highway Department at Ashland, Ohio, died there a few months ago. Mr. MacDowell was a graduate of Ohio Northern University.

George Totten Neuffer (M. '42), age 67, owner of a Dayton (Ohio) architectural and engineering firm bearing his name, died in that city on June 15. The firm, originally known as Geyer and Neuffer, was organized in 1922. Mr. Neuffer was an alumnus of the University of Cincinnati.

Frederick Yancy Parker (M. '09), age 92, who had been retired since 1935 died recently. He lived at Warwick, Va. A War Department engineer for 46 years, Mr. Parker worked on Western rivers and harbors. He was graduated from the University of Virginia in 1888.

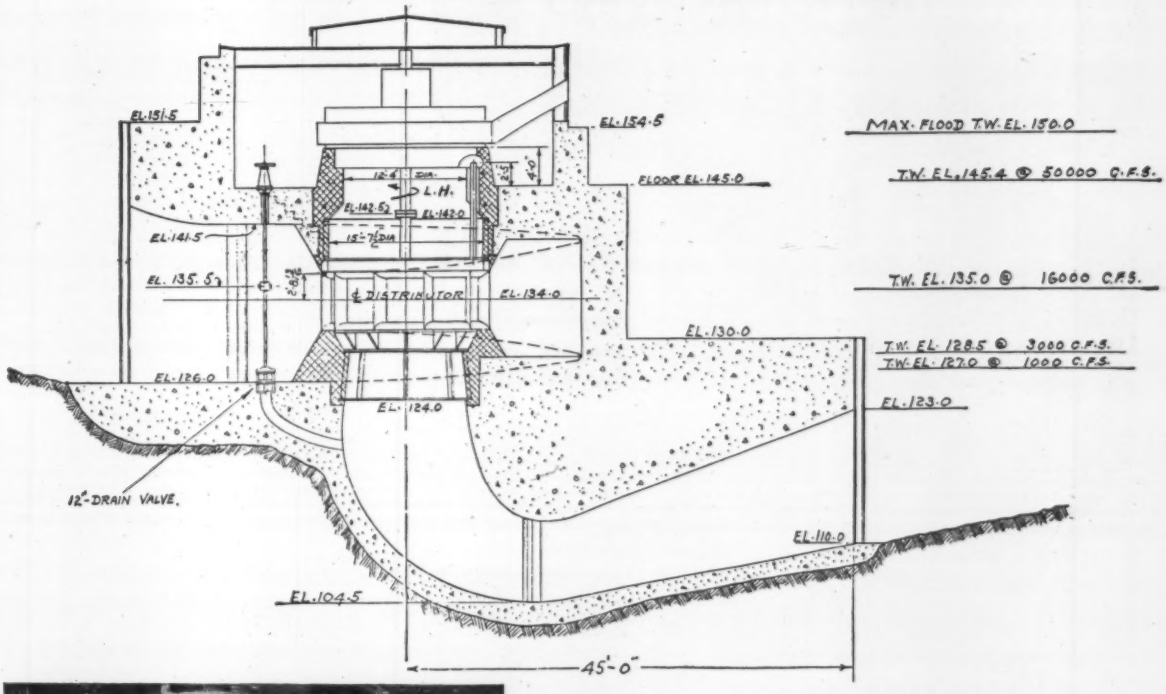
Delbert Walton Robinson (M. '45), age 57, engineer for Joe J. Rady & Co., consulting engineers of Fort Worth, Tex., died on June 5 in an automobile accident. Before going to Rady & Co., Mr. Robinson was for many years water and gas superintendent for the Community Public Service Co., Fort Worth. Mr. Robinson was educated at the University of Iowa.

Thomas R. Walter (A.M. '13), age 74, retired maintenance engineer for the Kalamazoo Paper Co., died recently. He lived at Doster, Mich. Mr. Walter had also been plant engineer for the company, and resident engineer for the Daniel W. Mead consulting firm at Madison, Wis. Mr. Walter was an alumnus of the University of Wisconsin.

(Continued on page 104)

at the Central Maine Power Company's Bar Mills Station

Two Leffel Turbines Help Boost Power Output By 150%



An increase in annual output from 8,500,000 KW hours to 21,000,000 KW hours is expected by the Central Maine Power Company as a result of the recently completed rebuilding of their Bar Mills Hydroelectric Station. Two Leffel turbines—replacing four smaller turbines installed in 1919—play a major role in the Bar Mills redevelopment.

Each of the turbines is rated to develop 3,000 HP at 120 RPM under a twenty foot net effective head. The turbines, of the fixed-blade propeller type, are installed in concrete spiral casings and mounted on curved concrete elbow draft tubes.

The top view at the left shows the completed power plant and dam; the bottom view shows the installation of the turbine stay ring and pit liner in the concrete spiral casing.

Here and throughout the world, Leffel turbines are economically and efficiently harnessing water power. Before you plan any future turbine installation, get the facts on efficient, reliable Leffel turbines tailored to meet all your hydroelectric power requirements. Write today for complete information.

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MORE EFFICIENT HYDRAULIC POWER FOR 95 YEARS

Faster BETTER CURB AND GUTTER LAYING at MUCH LESS COST

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STEPHENS-CANFIELD AUTOMATIC CURBER MODEL 55A

Save TIME, MONEY AND LABOR WITH THIS NEW METHOD

NO HAND FINISHING
NO FORMS

Operating on an entirely new principle by laying curbing and gutter by the extrusion method without forms or hand finishing, the Smith-Field Automatic Curb and Gutter Machine and the Stephens-Canfield Automatic Curbers offer a substantial savings in time, money and labor to the user.

Working equally well with either Asphaltic or Portland Cement concrete, the Smith-Field Automatic Curb and Gutter machine will lay up to 1,000 ft. of integral curb and gutter per day, under efficient methods and the Stephens-Canfield Automatic Curbers, up to 2,500 ft. per day.

Write for full details and prices

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PATENT NO. 2,707,422—AND OTHER PATENTS PENDING

Deceased

(Continued from page 102)

William C. Weeks (M. '07), age 85, retired Colonel, Corps of Engineers, died recently in Medford, Oreg. Colonel Weeks was in the Corps of Engineers from 1920 until his retirement twelve years ago. He was a veteran of both World Wars. A graduate of the University of Minnesota, he had been in charge of field work for the U.S. Coast and Geodetic Survey, and construction engineer for the Washington Water Power Co.

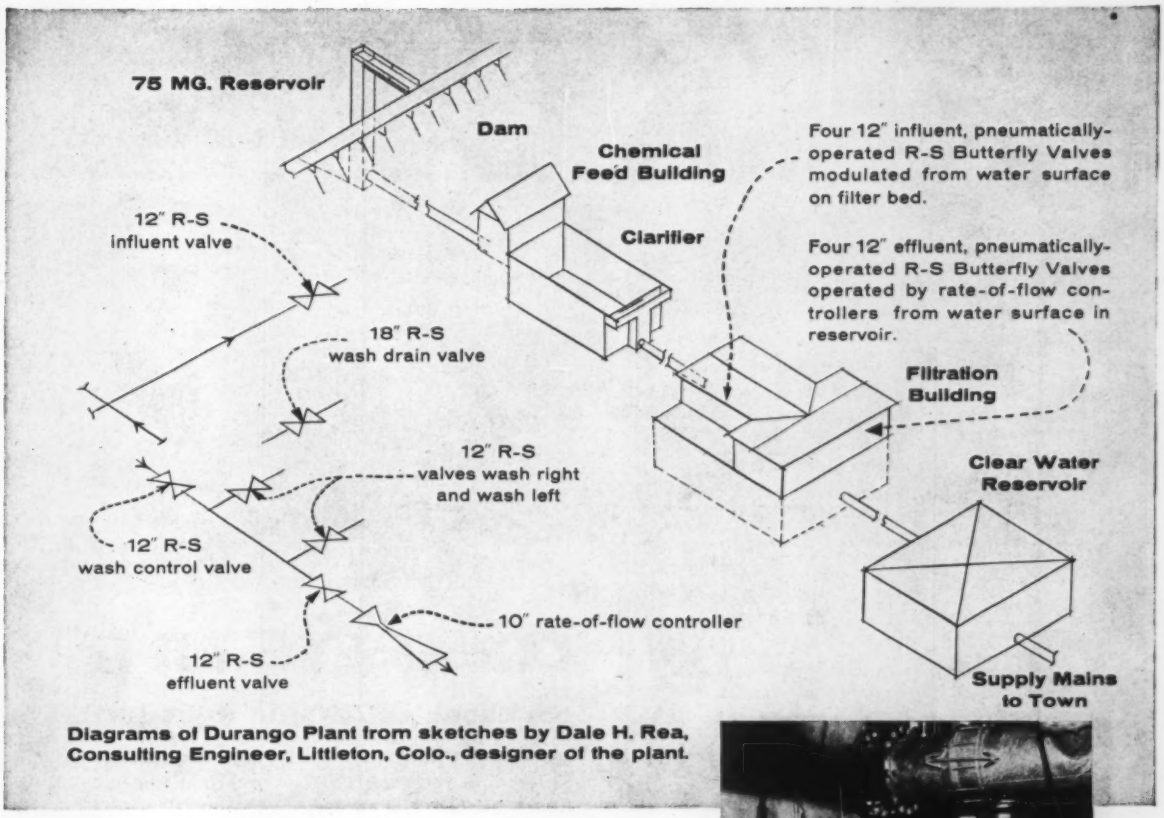
Eberhard Welle (M. '27), age 69, since 1950 structural design engineer for the Port of New York Authority and a resident of Clifton, N. J., died recently. Mr. Welle had been assistant engineer and assistant design engineer for the New York State Bridge and Tunnel Commission, and designing engineer for the Newark (N. J.) Transit Bureau. Mr. Welle was a graduate of Columbia University.

William Edward Wooley (A.M. '19), age 71, chief architect for the Borough Engineers Department, London, England, died in May. Mr. Wooley had been connected with the department since 1945, and earlier was with the Walthamstow Urban District Council. He had many engineering and architectural writings to his credit, including papers in ASCE TRANSACTIONS and PROCEEDINGS.

Positions Announced

City of Santa Clara, Calif. Announcement is made by the City of Santa Clara of an opening for the position of traffic engineer at a monthly salary of $550. Qualifications for the post are four years of college or a combination of two years of civil engineering studies along with two years of practical experience in traffic work. Apply to the City of Santa Clara, Personnel Office, Room 5, City Hall, Santa Clara, Calif.

United States Air Force. The Air Force announces its requirements for anticipated openings in the field of sanitary and industrial hygiene engineering. Applicants should be under 34 years of age and have a B.A. degree in sanitary, civil, chemical, or industrial hygiene engineering from an accredited college. Applicants between the ages of 28 and 34 will be considered for appointment as first lieutenant, and those under 28 years, as second lieutenant. Details about the program may be obtained by writing directly to the Chief, Liaison and Selection Division, Directorate of Staffing and Education, Office of the Surgeon General, USAF, Washington 25, D. C.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Dam
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Clarifier
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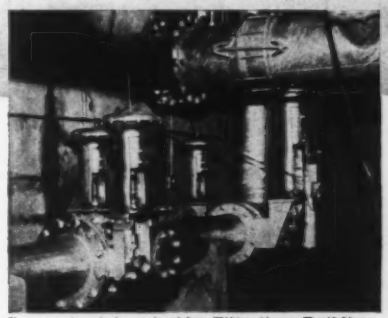
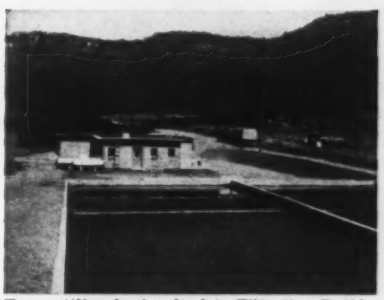
Diagrams of Durango Plant from sketches by Dale H. Rea, Consulting Engineer, Littleton, Colo., designer of the plant.



Compact piping inside Filtration Building shows rate-of-flow controller in left foreground, with wash and wash control valves behind it. This arrangement is diagrammed at left, above.



Two settling basins feed to Filtration Building in this 8.7 mgd system.

R-S Butterfly Valves used exclusively at Durango, Colorado,

TO GIVE CLOSE FLOW CONTROL

Durango, Colorado's 8.7 mgd water treatment plant operates automatically. But accurate flow control is necessary in this gravity system if the proper rate of flow in the treatment process is to be maintained. R-S Rubber-Seated Butterfly Valves were chosen to do this job. Their angle seating provides more desirable control characteristics. It means *more precise regulation over a greater range* than is available with 90° seated valves. 25 R-S Rubber-Seated Butterfly Valves, ranging from 12" to 18" in size, are installed here.

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CONCRETE PIPE

backbone of 72-mile aqueduct

The San Jacinto-San Vicente Aqueduct carries Colorado River water 72 miles to the San Vicente Reservoir near San Diego, California. The first barrel was completed with concrete pipe in 1947. When a second barrel was needed concrete pipe was specified again.

Built by the Bureau of Reclamation, the giant aqueduct is constructed of two types of concrete pipe: Non-cylinder pipe for hydrostatic heads up to 100 feet and a reinforced cylinder type for heads from 100 to 650 feet. Concrete pipe of 72-, 60-, 54- and 48-inch sizes was used. The photo shows a 48-inch pipe before backfilling.

Concrete pipe's smooth, non-corroding interior surface gives maximum hydraulic efficiency. Its dense structure and tight joints prevent leakage and infiltration. Its moderate first cost and low maintenance cost add up to real ***low annual cost.***

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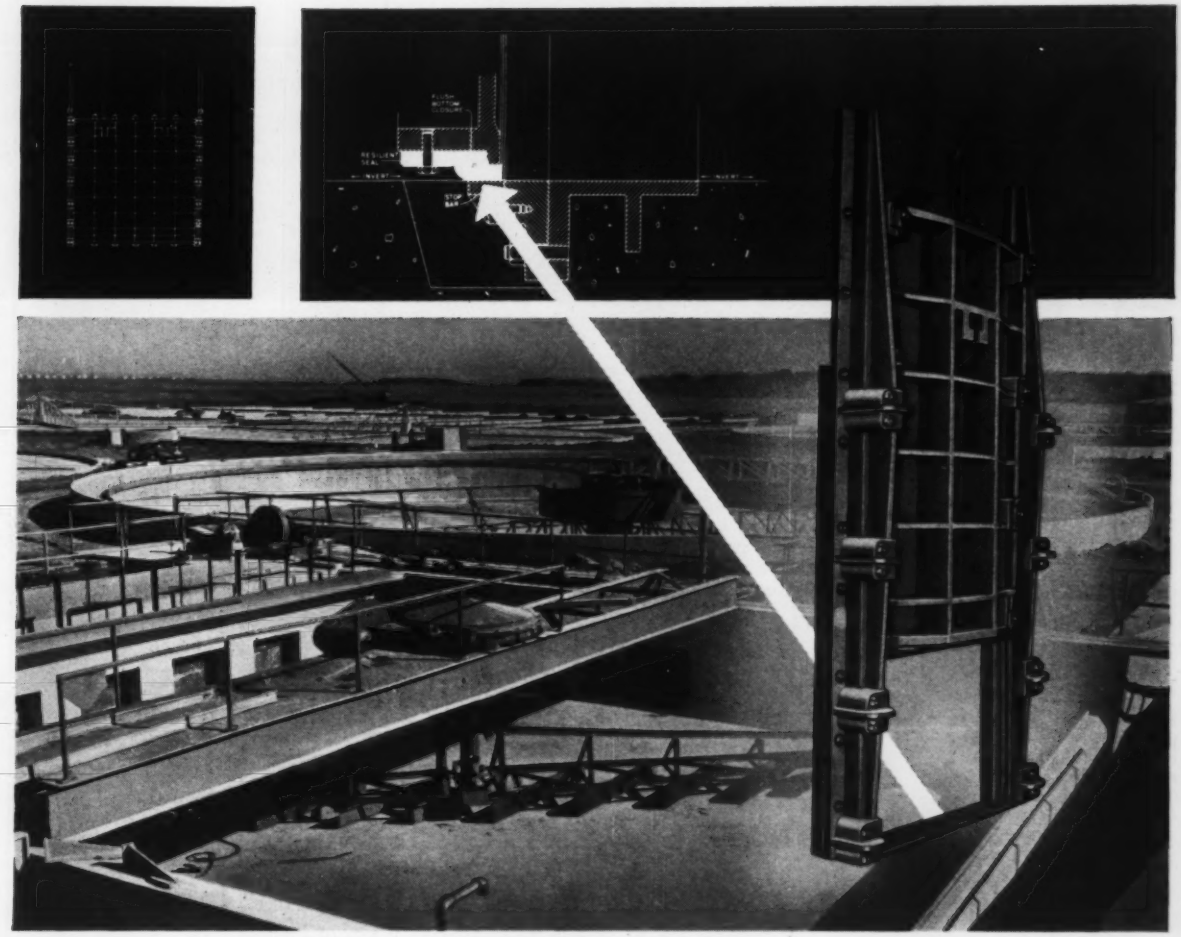

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HY-Q sluice gates assure maximum clear opening and greatest possible flow; reduce turbulence to a minimum. Improved flow means substantial economies . . . smaller gate size, narrower channel and lower channel walls. Because HY-Q gates seat at the lowest level of the channel, there is maximum hydraulic gradient. 16 Rodney Hunt sluice gates are used in this modern sewage treatment plant — Beaumont, Texas — pictured above.

Rodney Hunt HY-Q Sluice Gates with flush bottom closure are designed to give water control engineers and contractors far greater design flexibility in dams, water filtration, sewage, power plants, flood and irrigation projects. For further information write for Catalog No. 75.

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Four different Texaco Asphalt products were used in constructing the wearing surface, base and shoulders of this 15.7 mile South Dakota highway project.

South Dakota highway emphasizes Texaco Asphalt versatility

Contractor

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The construction of 15.7 miles of US-85A north of Pactola Dam in South Dakota demonstrates the all-around service of Texaco Asphalt products to the road builder. Four of these products went into the building of this important highway. They were used in both the surface and base of the road, as well as the shoulders.

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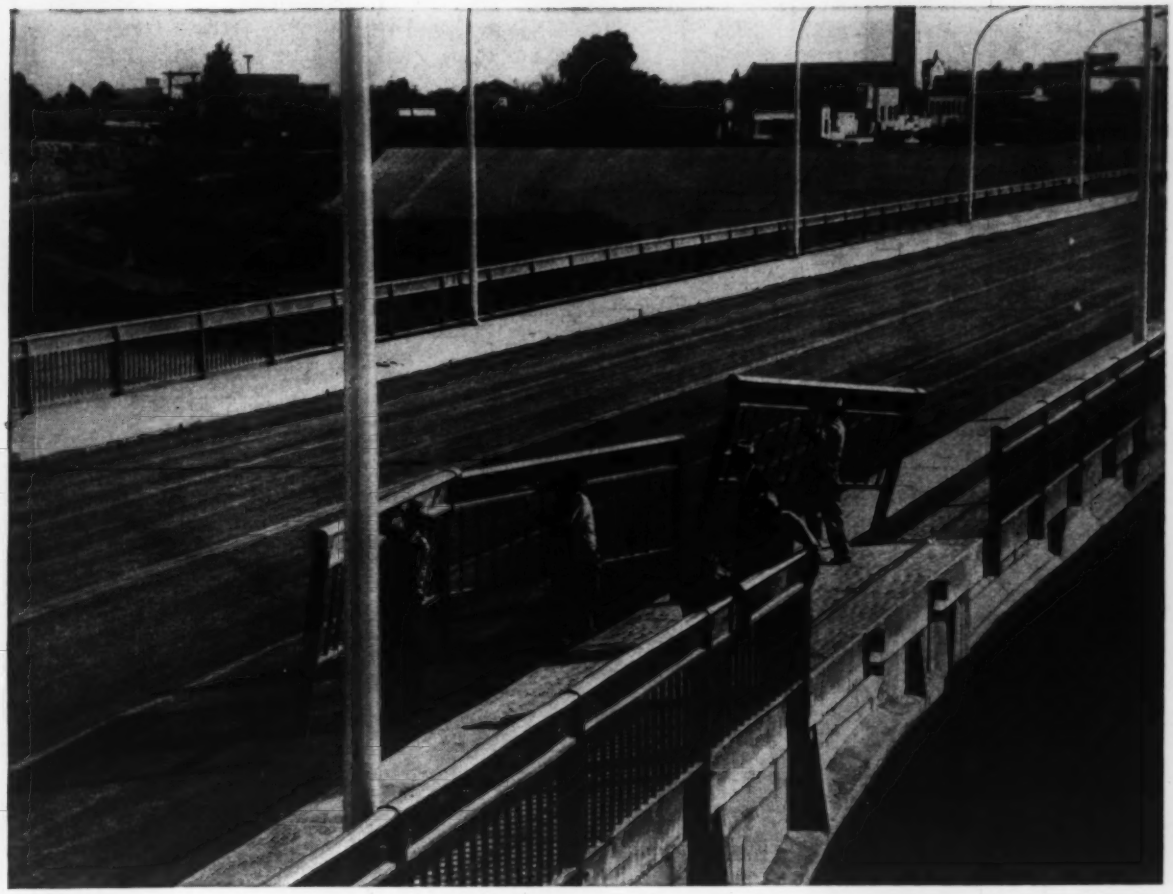

23-year-old ALCOA ALUMINUM bridge railing still on the job at Laredo

Every time floods sent the Rio Grande rampaging past Laredo, Texas, International Bridge authorities had troubles. The climax came in 1932, when roaring water tore out the original concrete railing. Then came a startling development. . . .

With Alcoa® Aluminum Bridge Railing, light in weight and designed in demountable sections, it took only 90 minutes to remove all 1,720 feet of railing whenever high water threatened. Such removal streamlined the bridge, lessening chances of damage.

But in 1954, when the flood crest hit 62 feet, nothing could save the structure. The bridge was lost, but the railing was safe in storage. And when rebuilding plans were laid, they called for re-use of the same Alcoa Aluminum railing. "Why not?" said authorities. "It's just as good as new!"

It was, and it is—even 23 years after original installation. Yet it has never needed a nickel's worth of painting and its lasting strength continues to safeguard more than 1,400 pedestrians and 8,000 vehicles daily. You couldn't ask for better proof of the farsighted economy gained with Alcoa Aluminum Bridge Railing. For experienced counsel on design and installation, call your Alcoa sales office. Aluminum Company of America, 1979-H Alcoa Building, Pittsburgh 19, Pa.

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From coast to coast thrift-minded owners report:

"Climbing the 1,200-foot ramp that rises 100 feet from pit to primary crusher, our '95' Payhauler averages a 22-ton load of shot granite every 8 to 10 minutes," reports Supt. H. C. Burgess, for Superior Stone Co., Woodleaf, North Carolina. "Production of this hauler unit is 1,000 tons per 7 hours." And the "95's" turbocharged diesel burns only 4½ gallons of low-cost fuel per hour on this tough quarry job!

"Grade-beating, rock-speeding Payhauler® gives us the decisive profit margin of difference!"

"The fast reverse of the '95' Payhauler is a big advantage on narrow, one-way haul roads—enabling our two units to keep the big shovel busy," states Howard Durbin, for Durbin Brothers, Eugene, Oregon. "Our other haulers with slow back-up could not do this."

"Down switch-back grades as steep as 30%, the '65' Payhauler takes its loads—then climbs back out at fast speeds," declares Supt. Howard Eaton, for Funderburk Construction Co., Sutherlin, Oregon. "The best of the other haulers of this size just can't keep going on our tough Roberts Mountain haul road, like the '65' can!"

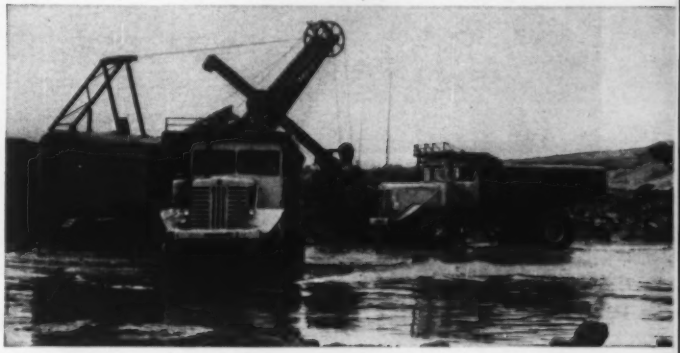
"Two '95' Payhauler trucks (24-ton capacity) replaced three 15-ton competitive haulers, and handle the operation with ease," says Supt. Henderson Hawkins, Stone Mountain Grit Co., Lithonia, Ga. "With unusually fast hoist, good balance, and speedier delivery, the '95's' reduce spotting and dumping time, also save 20% on fuel."

On tough St. Lawrence Seaway—for United Waterways Constructors—11 '95' Payhauler trucks are sparking a demanding monthly production schedule of 120,000 cu yd of rock, and 100,000 cu yd of common earth. *Next-to-automatic* Payhauler control gives safe, capacity-adding speed over rough terrain!

At 7,600 feet altitude, a fleet of 4 turbocharged diesel-powered "95" Payhauler units help Morrison, Walsh & Perrini highball rock-fill to build Wishon Dam—in Sierra National Forest, California. All 4 operators vote superior riding comfort, torqmatic braking safety, hand-operated dumping brake, as stand-out '95' advantages!

"Engine power matches hauler capacity, to pull a 20-22 ton load from the quarry in second gear, over haul-road grades as steep as 15%," reports J. L. Sutherland, '65' Payhauler operator for Jefferson County Stone Company, Anchorage, Kentucky. "The Payhauler rides good, has excellent visibility, and maneuverability, shifts easy."

Prove an International Payhauler's production-boosting speed! The "95" is turbocharged diesel-powered to highball at 38 mph—the "65" at 36.4 mph! Try the "pick-up truck" spotting ease—using exclusive high reverse and "zip-around" power steering to position the "big-target" body, double-quick. Compare how the double-acting hydraulic hoist, under exclusive hand-brake control, gives 10-to-12-second dumping. Measure the big profit-building margin of difference—see your International Construction Equipment distributor for a Payhauler demonstration!



Satisfaction with two Payhauler trucks on one successful rock-moving contract prompted Clarkson Construction Co., Kansas City, Mo., to add three more "95's" to their fleet—to help handle a new, bigger contract. "Best production I've ever had," says Project Superintendent H. D. Brown.

"Our three '65' Payhauler trucks move up to 2,000 cu yd of shot rock per 10 hours on a 1,200-foot delivery haul," states Warren Greer, for Greer Brothers and Young, London, Kentucky. The contractor is using these trucks to move 165,000 cu yd of shot rock relocating a section of U. S. 27 in Lincoln County, Ky.

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Divers flame-cut steel H-piles in 34 ft of water for Housatonic River Bridge piers.

Steel Cofferdam Construction Used for River Bents of New Housatonic River Bridge

Substructure for the Connecticut Turnpike's Housatonic River Bridge, connecting Stratford and Milford, Conn., consisted generally of 24 land bents and nine river bents, plus abutments.

Steel cofferdam construction was used for all nine river bents. Typical was Pier IE, shown here. Excavations were carried down about 40 ft below mean sea level, and two sets of steel frames were used to support the cofferdams. The frames were brought to the job site by barge.

General pile cut-off was about 34 ft below sea level with the piles extending some six feet into the 13-ft thick tremie. Maximum length of the steel piles ran to a spliced 96 ft.

Bethlehem supplied 2083 tons of steel H-piles and 451 tons of sheet piling for the Housatonic bridge substructure. Consulting engineers for the Connecticut State Highway Department were Parsons, Brinkerhoff, Hall and MacDonald of New York. Substructure contractor was Savin Corporation of East Hartford, Conn.

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CIVIL ENGINEER, M. ASCE; 54; civil graduate; 30 years' private and public practice; registered New York, North Carolina, Virginia, Maryland, Nebraska, Washington, D.C., and Ohio; N.B.-E.R. certificate of qualification. Administrative and supervisory experience in diversified fields; turnpikes, airfields, water, sewage and waste treatment, dams, investigations, reports, planning, specifications, estimates, contracts, supervision, and construction materials. Available at once. Prefers South. C-236.

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CIVIL ENGINEER, J.M. ASCE, C.E., E.I.T., 28, two years' commercial and industrial building; desires field and/or office position in western or upstate New York. C-245.

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SENIOR ENGINEER, mechanical or civil graduate or equivalent, with 2 to 5 years' experience covering steam electric power plant construction. Should be qualified to estimate materials (especially piping) from design drawings, expedite procurement and deliveries from vendors, assist in supervision of installations. Should be familiar with high-pressure code requirements covering welding. Salary to $8,300 a year. Location, western Pennsylvania. W-4916—D-3889.

SAFETY ENGINEER, experienced in construction safety procedure. Ability to instruct and train unskilled native help in safety practices. Single status. Salary based on recent past earnings, plus 25 percent overseas differential, plus 20 percent for overtime for six-day week. Location, Korea. F-4921.

CIVIL ENGINEERS, Designers, experienced in various phases of highway and/or airfield designs and capable of directing small squad of engineers. Also recent graduates interested in gaining experience in these fields. Salaries open. Location, central Ohio. W-4953.

ASSISTANT PROFESSOR, graduate civil engineer to teach courses in highway construction. Should have 3 to 5 years' field and office experience in highway design, construction, and surveying. Teaching experience highly desirable. May teach following subjects during the school year: Surveying, estimating, drafting, highway design and office practice. Salary, $5,748-$7,470 a year, with 1 month's vacation; extra compensation for evening school instruction. Location, New York Metropolitan area. W-4989.

ENGINEERS. (*a*) Sales Representative, preferably civil graduate, with experience in concrete construction and sale of building materials. Salary $6,000 a year plus bonus. (*b*) Construction Superintendent with at least 5 years' field engineering and supervisory concrete construction experience. Salary $8,000-$10,000 a year. Headquarters, New York City. W-5038.

INSTRUCTORS for civil engineering department; bachelor's degree preferred, so that specialization may fit instructor and departmental needs. Extra work for consultants permitted. Graduate courses may be taken. Salary $4,050 for 9 months. Position available September 1, 1957. Location, South. W-5049.

OFFICE ENGINEER, civil, mature, for an engineering and surveying practice. Must be able to organize work and trouble-shoot difficulties in both field and office. Experience and ability are prime requisites. Location, western Pennsylvania. W-5055.

TEACHING PERSONNEL for Department of Civil Engineering. (*a*) Instructor, B.S. in C.E., to teach engineering drawing, descriptive geometry, plane surveying and mechanics. Salary dependent upon education and experience. (*b*) Assistant Professors, two, M.S. degree preferred; subjects to be taught dependent upon interest and experience. Salary dependent upon interest and experience. Location, Midwest. W-5061.

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OFFICE ENGINEER, graduate civil, with 5 to 10 years' experience in heavy and highway construction; both office and field experience desirable; for medium-sized contracting firm engaged in heavy and highway construction. About 80 to 90 percent of time will be spent at project offices in the field. Permanent; excellent opportunity. Salary open. Location, Midwest. W-5203.

PLANT AND YARD OPERATOR—PRESTRESSED CONCRETE; with complete experience in prestressed concrete, both in plant operation and marketing for a new plant to be set up in Manila by well established company. Location, Manila. S-2947.

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(Added to the Engineering Societies Library)

ASTM Standards on Cement

A compilation of all the ASTM standards pertaining to cement, substantially revised since publication of the previous edition in 1955. Seven of the 34 standards have been revised and one test method has been discontinued. In addition to specifications and tests, the publication contains appendixes giving information on balances and weights, a manual of cement testing, selected references on Portland cement, and other data. (The American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 1957. 264 pp., $3.00.)

(Continued on page 116)

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Recent Books

(Continued from page 115)

Automatic Digital Calculators

Second Edition, 1956

An introduction to the theory, design, construction, and use of digital calculators, by A. D. Booth and K. V. H. Booth, intended for engineers new to the field. The book has been revised to include information on automatic coding procedures and on new circuit elements such as the transistor and the ferro-electric matrix store. The bibliography is more than twice as long as that in the first edition. (Academic Press, Inc., Publishers, 125 East 23rd Street, New York 10, N. Y. 261 pp., $6.00.)

Control of Steel Construction to Avoid Brittle Failure

Prepared by the Plasticity Committee of the Welding Research Council, this compact volume is a general reference and guide for engineers, fabricators, and designers in the structural field. Part I deals with the basic concepts and mechanisms of notch brittleness and with the mechanical and metallurgical factors affecting the plastic behavior of structural materials. Part II shows how conventional fabrication procedures affect notch ductility of these materials. Part III deals with the selection of materials and fabricating procedures; the limits of conventional design methods; and the use of notch-brittle test data. (Edited by M. E. Shank. Welding Research Council, 29 West 39th Street, New York 18, N. Y., 1957, 184 pp., $4.50.)

The Draining of the Fens

Second Edition, 1956

An intriguing and very well-documented economic history, by H. C. Darby, of the fenland of Northeast England beginning with the period of the dissolution of the monasteries in the 16th century and following through the 19th century, with an epilogue on conditions after 1900. The period covered includes the draining project before and after the English Civil War, the use of windmills particularly in the eighteenth century, and the advent and agricultural consequences of the steam engine. Plates, maps and diagrams show windmills and their mechanism, plans and locations of sluices and comparisons of original circumstances with conditions as they now exist. (Cambridge University Press, 32 East 57th Street, New York 22, N. Y. 314 pp., $6.50.)

Digital Computer Programming

A general introduction to the entire field intended for engineers and others who want to know how to prepare detailed instructions for the stored program computer. Emphasizing basic principles, the book discusses coding, binary and octal number systems, input-output methods, magnetic tape programming, automatic coding, and other aspects of programming. The discussion is illustrated by detailed examples written for a mythical computer representing major trends in present computer building. (By D. D. McCracken. John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1957. 253 pp., $7.75.)

Elastic Waves in Layered Media

The outgrowth of a plan to make a uniform presentation of investigations on earthquake seismology, underwater sound, and model seismology, by W. M. Ewing, W. S. Jardetzky and F. Press, the scope of this book was enlarged to include a selection of related problems. Many of the methods used in seismological problems were originally developed in studies on electromagnetic waves and in general the methods used in the work covered by this book are close to those used in electromagnetic waves, water waves and

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shock waves. (McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y., 1957, 380 pp., $10.00.)

Elektronische Rechenmaschinen und Informationsverarbeitung

A compilation of more than 60 conference papers on electronic digital computing and information processing, of which one-fourth are in English, the rest mainly in German with brief English abstracts. The major sections are divided as follows: generalized topics; development of various actual computers; machine elements, switching circuits, and memory units; programming; numerical processes, with illustrative examples; special cases and switching theory. (Nachrichtentechnische Fachberichte, Band 4. Friedrich Vieweg & Sohn, Braunschweig, Germany. 1956, 229 pp., paper. DM 26.00.)

Engineering Economics and Ethics for Professional Engineer's License

Brief notes and worked-out examples, by John D. Constance, from past state examinations for professional engineer's license. The subject matter includes bond issues, bond valuation, debt amortization, property valuation, depreciation, cost analysis, contracts, specifications, business law, and professional ethics and practice. (John D. Constance, 625 Hudson Terrace, Cliffside Park, N. J., 1957. $2.50.)

Engineering Economy

Second Edition, 1957

The theory and practice of the determination and evaluation of economic factors, by H. G. Thuesen, are here set forth for engineers and engineering students. This edition, in addition to general revision, has a new chapter on income taxes in engineering economy studies. Other subjects treated in the book include: depreciation; first, fixed, variable, incremental, differential, marginal, and sunk costs; break-even and minimum cost points; evaluation of replacements; and economy and utilization of personnel. (Prentice-Hall, Inc., Englewood Cliffs, N. J. 581 pp., $6.95.)

Nuclear Reactors for Research

In this third volume in the Geneva Series on the Peaceful Uses of Atomic Energy, Part I contains the following sections: The kinds of institutions that may wish to build and install a research reactor, and their fields of research; technological factors affecting choice; performance data, safety considerations and the uses of research reactors in physics, chemistry, engineering, and biology. Part II describes research reactor projects of all types now in operation at specific locations in Europe and America, including Russia. The book provides a list of the papers relevant to research reactors presented at the 1955 Geneva Conference, a subject index, and a name index. (Edited by Clifford K. Beck. D. Van Nostrand Company, Inc., 120 Alexander Street, Princeton, N. J., 1957. 267 pp. $8.50.)

Fundamentals of Statically Indeterminate Structures

A college text, by Carl L. Shermer, which focuses attention on the basic concepts of statically indeterminate structures. All methods and topics are carefully related and coordinated through their development from these fundamental concepts, and the subject is developed as an integrated whole rather than a consideration of numerous unrelated methods. The book is planned so that it may be used as a text in a one- or two-semester course. (The Ronald Press Company, 15 East 26th Street, New York 10, N. Y., 1957, 264 pp., $6.50.)

The Physics of Flow Through Porous Media

This volume, by Adrian E. Scheidegger, represents an attempt to correlate the essence of the information on hydrodynamics in porous media scattered in many separate papers. It covers physical theories of flow, including a theoretical deduction of Darcy's law, the Kozeny theory, and statistical flow theory. Also covered are methods for solutions of flow problems for turbulent flow, molecular flow, and flow with absorption. The bibliography includes about a thousand references. (The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y., 1957. 236 pp., $14.00.)

Library Services

Engineering Societies Library books may be borrowed by mail by ASCE members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply photoprint or microfilm copies of any items in its collections. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th Street, New York 18, N.Y.

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Non-ASCE Meetings

American Institute of Chemical Engineers. Meeting at the Lord Baltimore Hotel, Baltimore, Md., September 15-18. For information write to F. J. Van Antwerpen, Secretary, AIChE, 25 West 45th St., New York 36, N. Y.

American Institute of Electrical Engineers. Pacific General Meeting at the Pasco Senior High School, Pasco, Wash., August 28-30. Details may be obtained by writing to Edward C. Day, Technical Secretary, AIEE, 33 West 39th Street, New York, N. Y.

American Public Works Association. Public Works Congress and Equipment Show at Grand Exhibition Hall, Philadelphia, Pa., September 22-25. Information from American Public Works Association, 1313 East 60th Street, Chicago 37, Ill.

Building Research Institute. Plastic Study Group Meeting at Washington University, St. Louis, Mo., September 17-18. For advance information write to Harold Horowitz, Technical Secretary, Building Research Institute, 2101 Constitution Ave., Washington 25, D. C.

Council on Wave Research. Sixth International Conference on Coastal Engineering, co-sponsored by the College of Engineering, University of Florida, Gainesville, will meet at the University of Florida, Palm Beach, and Miami Beach, December 2-7. Information may be obtained by writing to Prof. J. W. Johnson, 200 Mechanics Building, University of California, Berkeley 4, Calif., or Dr. Per Bruun, Coastal Engineering Laboratory, University of Florida, Gainesville, Fla.

Engineers Joint Council-Engineers' Council for Professional Development. Engineers General Assembly, a conference of the two organizations, will meet at the Statler Hotel, New York, N. Y., October 24 and 25. Information from Dr. J. W. Barker, President, Engineers Joint Council or from M. D. Hooven, President, Engineers' Council for Professional Development, both located at 29 West 39th St., New York 18, N. Y.

Federation of Sewage and Industrial Wastes Associations. Thirtieth Annual Meeting at the Hotel Statler, Boston, Mass., October 7-10. For further information write to the Federation at 4435 Wisconsin Avenue, Washington 16, D. C.

National Association of Corrosion Engineers. North Central Region Meeting at the Sherman Hotel, Chicago, Ill., October 1-4. For details write to A. B. Campbell, Executive Secretary, National Association of Corrosion Engineers, 1061 M & M Building, Houston 2, Tex.

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Applications for Admission to ASCE, June 8-29

Applying for Member

George Leo Berson, Raleigh, N. C.
William Mitchell Bolton, New Haven, Conn.
Dewey Wall Boren, Abilene, Tex.
Martin Patrick Callan, Washington, D. C.
Andre Gardel, Lausanne, VD, Switzerland.
Norman Groves Hansen, Alexandria, Va.
Eugene Edward Howard, Jackson, Miss.
Joseph Jackson, Herts, England.
James Sheldon King, Oak Park, Ill.
Dorland Henry Konichek, Seattle, Wash.
George Charles Madgouranis, Chicago, Ill.
Ivan Benjamin McBride, South Charleston, W. Va.
John Oliver McCutcheon, Westmount, Que., Canada.
Emygdio de Moraes Vieira, Rio de Janeiro, Brazil.
Robert Osamu Ohata, Lihue, Kauai, T. H.
George Hiram Paris, Mt. Prospect, Ill.
Bernard John Parker, Providence, R. I.
Lloyd Eugene Root, Pearl Harbor, T. H. Hawaii.
William Furber Smith, Chicago, Ill.
Paschal Neilson Strong, Savannah, Ga.
Otto B. Van Horn, Omaha, Nebr.
Philip Carl Wagner, Massena, N. Y.
Thomas Alfred Woods, Washington, D. C.

Applying for Associate Member

John Warner Allen, Velasco, Tex.
Thalis John Argyropulos, London, England
Howard Cromwell Bailey, Baltimore, Md.
David Ian Hunter Barr, Glasgow, Scotland.
James Richards Barton, Fort Collins, Colo.
Roberts Blukis, Prairie Village, Kans.
James Royden Bolton, Ft. Belvoir, Va.
Clarence Eugene Brown, Schenectady, N. Y.
Joseph Dahm Brunner, Santa Ana, Calif.
John Davis Bryant, Massena, N. Y.
Audie Vernon Cardin, Shreveport, La.
Edward Patrick Delany, Salisbury, Southern Rhodesia.
Charles Richard Eslinger, Kansas City, Mo.
Robert Joseph Dugan Finfrock, Orlando, Fla.
Zbignien Marian Gliniecki, Middlesex, Great Britain.
Howard Fulton Greenspan, East Orange, N. J.
Joseph Epps Greer, Jr., Paris, France
Joe Nels Henningsen, Rolla, Mo.
Dean Edward Hodges, Eugene, Ore.
John Roberson Hollinshead, Nashville, Tenn.
Harold Clinton Levy, Long Beach, Calif.
Carter Denson Messick, Jr., Annapolis, Md.
Mujib Salim Metti, Baghdad, Iraq.
Emory S. Miller, Towson, Md.
Robert Boyd Miller, Lanikai, Hawaii.
Gilbert Kayo Minn, Honolulu, T. H.
John Edward Moody, Tulsa, Okla.
Philip Franklin Moyer, New York, N. Y.
Kolar Shamaiyer Srinivasa Murthy, Orrisa, India.
Harry Raymond Nara, Cleveland, Ohio.
Ismet M. Ordemir, Cambridge, Mass.
Walter Robert Page, Nashville, Tenn.
Tadeusz Jozef Pilecki, Oakland, Calif.
Juan Manuel Quiros Oreamuno, San Jose, Costa Rica.
Taduri Venkata Ramana Rao, Kakinada, India.
James Francis Regan, Boston, Mass.
John G. Ruby, West Islip, N. Y.
Robert Reuben Schneider, La Mirada, Calif.
Howell Dewitt Wood, San Francisco, Calif.
Cecil Emery Tackett, Superior, Nebr.
Ben Wiley Young, Corpus Christi, Tex.

Applying for Affiliate

James Gordon McIntyre, Orlando, Fla.

Applying for Junior

Raymond Babcock, Denver, Colo.
Jacques Cohen, Gainesville, Fla.
Ronald Kenneth Deeprose, Alberta, Canada.
William Chester Dodge, Jr., Cranston, R. I.
William Murray Eddy, Elk City, Okla.
Baudelio Casillas Escobar, Glendale, Calif.
Kaare Sigfred Flaate, Urbana, Ill.
Charles Spies Graber, Elmhurst, Ill.
Douglas Dean Kennedy, Clute, Tex.
Arnold Kupferman, Flushing, N. Y.
Lorenzo Dow Nichol, III, Washington, D. C.
Kenneth Ozer, Brooklyn, N. Y.
Joe Mann Rainey, Shreveport, La.
James Allen Reddington, Los Alamos, New Mexico.
Paul Herbert Sanders, Pittsburgh, Pa.
Allen Benjamin Schwartz, Providence, Rhode Island.
Charles Richard Smith, Blacksburg, Va.
George Bela Szabo, Los Angeles, Calif.
James DeWitt Tapp, Jr., Raeford, N. C.
Simon Van der Mik, Cambridge, Mass.
Thomas John Van Orden, Midland Park, N. J.
Richard Engel Werling, Roseville, Mich.
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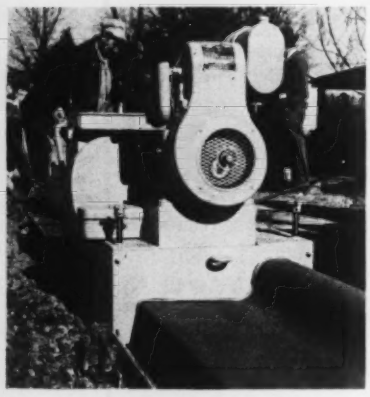

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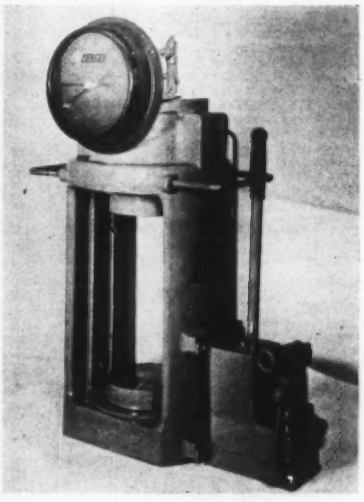

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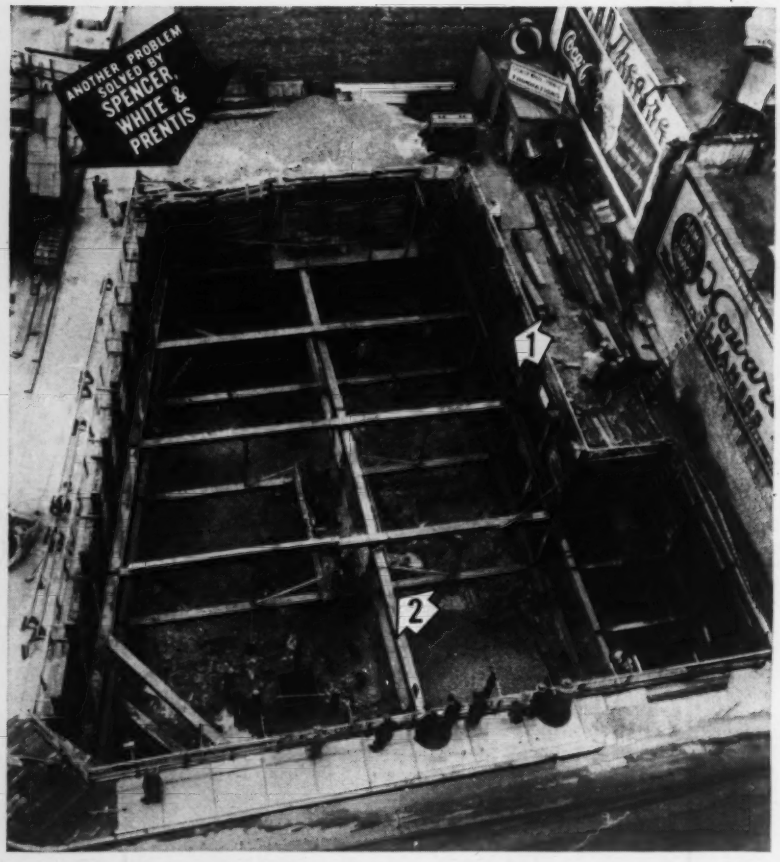

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2. TWO TIERS OF CROSS-LOT BRACING
BOTTOM OF EXCAVATION 30 FT. BELOW CURB

Project: Sewage pump station and office building for Hampton Roads Sanitation District Commission
Engineers: Buck, Seifert & Jost, New York City
General Contractor: W. F. Magann Corp., Portsmouth, Va.

In the center of downtown Norfolk, just a few blocks from the waterfront, a deep and unusually difficult excavation was required, in wet clay, sand and silt, almost entirely below ground water.

In view of much past experience in the area, it was assumed that steel sheeting would be required. Spencer, White & Prentis specialists, however, solved the problem successfully (and more economically) using soldier beams and horizontal wood sheeting. Existing electrical utilities and buildings, which added to the complexities of the job, were in no way disturbed.

On request, we will be happy to explain the planning and procedures used to achieve these out-of-the-ordinary results.

CATALOGUE ON REQUEST

Spencer, White & Prentis Inc.

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EQUIPMENT MATERIALS and METHODS

(continued)

New Size Tubing

SQUARE AND RECTANGULAR structural steel tubes in continuous 24-ft unspliced lengths and up to 32-in. in girth are now available for the construction industry. Thickness of the tubing will be increments from ⅛-in. to ½-in. These welded tubes meet the most rigid standards for longitudinal accuracy and precise alignment of butts is assured since there are no "off-square" shoulders or twist. Beading is eliminated during their fabrication, insuring a smooth outer surface. **Union Asbestos & Rubber Co., CE 8, Bloomington, Ill.**

Winter Foundation Job

FORMING ON A FOUNDATION JOB was produced last January by teaming balsam wool insulation with Symons Standard Wood-Ply panels. 50% on the cost of heating and curing the concrete was saved although outside temperatures ranged from 5 to 25 above 0.

Concrete at the time of the pour was held in the 70 to 80° range. After 72-hrs the temperature between the backside of the forms and insulation was 82°. In a later pour, the temperature, after 24-hrs, at the center of the concrete rose to 106 and after 5 days went back to 78.

This system replaces the normally costly methods of tarpaulins or protective enclosures and portable heaters on the job. This eliminates the fire hazard and valuable time can be gained by starting forming jobs in winter despite cold weather. **Symons Clamp & Manufacturing Co., CE 8, 4249 Diversey Ave., Chicago 39, Ill.**

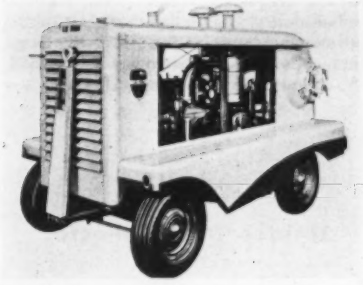
Rotary Air Compressor

THE 600RD2, A PORTABLE, 2-stage, sliding vane type, has been announced as the lightest, shortest-turning 600-cfm rotary air compressor made to date. Coupled to a GM-71 diesel engine with a hydraulically activated clutch, it has a turning radius of 11-ft, 11-in. and dry weight is 7730-lbs. By use of an automatic variable capacity regulator and an automatic governor speed control, engine speed varies to match air demands.

The engine-compressor is supported on a unit welded steel frame and is enclosed in heavy metal. Automotive type steering, tapered roller wheel bearings, and 7.50 by 16 8-ply tires provide safe, easy towing. The towbar, with a double spring drawbolt to absorb both forward and rearward shock, is located at the engine end of the unit and can be locked in a

vertical position for minimum storage dimensions.

The combination air receiver-oil separator is mounted above a reservoir located at the rear of the unit, where oil for lubrication and cooling of the compressor is stored. This provides for maximum oil separation for drainage to the oil reservoir. An easily removable, posi-



600RD2

tive gear type oil pump is directly driven off the high pressure rotor shaft.

A side-by-side arrangement of individually cast cylinders, which can be removed separately or with the gear drive, provides compactness, ease of inspection, and greater accessibility. **Le Roi Division, Westinghouse Air Brake Co., CE 8, Milwaukee, Wis.**

Adjusto-Slide Motor Base

WITH THIS NEW MOTOR base, belt take-up is accomplished by adjusting only one screw, an adjustment that is safely made without stopping the motor. Replacement of belts is also simple, for the adjusting screw can be loosened and swung aside, freeing the top plate and the motor to move far enough for removing the old and installing the new belt. Once the belt is in place, the motor is moved back in place, the adjusting screw swung back, tightened and the machine is back in operation. **American Pulley Co., CE 8, 4200 Wissahickon Ave., Philadelphia 29, Pa.**

Private Line Radio

THE NEW 450-470 mc Private Line radio, which literally "shuts out" communications from other users operating on the same channel, eliminating nuisance noise and unwanted messages, is now available for the UHF band.

This new model dispenses with the traditional manual squelch control making it even simpler to operate than

(Continued on page 124)

SONOTUBE®
FIBRE FORMS
save time, labor, money!

Providence River Bridge, North-South Freeway, Providence, R. I., Rhode Island Dept. of Public Works, Div. of Roads & Bridges. M. A. Gammino Company, contractors. Charles A. Maguire & Associates, Boston, consulting engineers. Photo: Courtesy New England Construction.

Three-foot diameter

SONOCO SONOTUBE®

formed the piers for this bridge!

The typical river bent for the Providence River Bridge included a concrete girder about 140 feet long supported on eight three-foot diameter round concrete piers formed by low-cost Sonoco SONOTUBE Fibre Forms.

These columns, in turn, are supported by a solid granite-faced pier section resting on a heavy tremie seal foundation and long steel H-piles.

SONOTUBE Fibre Forms save time because they erect quickly . . . save labor because they require minimum bracing and are easy to handle . . . save money because they are economical to use!

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NEW TECHNICAL MANUALS ON WATERSTOPS AVAILABLE

We have prepared, in conjunction with various testing companies, a series of factual, technical reports on the subject of waterstops. These Technical Reports cover the many aspects of adequate concrete joint design and should prove to be a valuable addition to your design files. Although these reports are strictly technical information and not sales catalogs, they conclusively prove that DURAJOINT and DURASEAL PVC Waterstops are the only waterstops on the market that will produce a practically 100% watertight joint. Check the coupon below for your free copies of these Technical Reports. Why not mail it now while you are still thinking about it?

MAIL THIS COUPON TODAY!

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. . . a series of Technical Data Sheets that contain complete information on the design, handling, splicing, installation and structural recommendations on the application of DURAJOINT and DURASEAL Waterstops. Send coupon today for your free set of DURAJOINT "Tech-Tips."

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"DURAJOINT" enjoys national distribution through the distributors of Tecon Inc. in the 11 western states and W. R. Meadows, Inc. in the 37 states of the mid-western, southern and eastern portions of the United States.

DURAJOINT TECHNICAL INFORMATION *Center*

121 HILL AVENUE • AURORA, ILLINOIS

Please send me, without obligation, the following:

- ☐ **TECHNICAL REPORT NO. 1...** How Cross Section Design Affects Bonding to the Concrete.
- ☐ **TECHNICAL REPORT NO. 2...** Tests and Methods of Testing Polyvinylchloride Waterstops.
- ☐ **TECHNICAL REPORT NO. 3...** DURAJOINT Tests and Test Results by the U. S. Testing Company, Inc.
- ☐ **TECHNICAL REPORT NO. 4...** Hydrostatic Pressure Tests on DURAJOINT and other Waterstops.
- ☐ **DURAJOINT "Tech-Tip" Series.**
- ☐ **Have representative call.**

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CITY_____ STATE_____

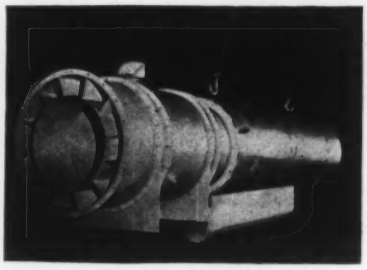
EQUIPMENT MATERIALS and METHODS

(continued)

conventional equipment. New circuitry eliminates the normal noise "burst" at the end of each transmission. Heated oven-type crystal assemblies utilized in the receiver's control oscillator circuitry provide exceptionally close tolerance overall frequency stability for the receiver unit and thereby maximize radio coverage. **Motorola Inc., CE 8, Communications and Electronics Div., 4501 W. Augusta Blvd., Chicago 51, Ill.**

Unique Dust Collector

THE JOY MICRODYNE dust collector is a wet, inertial type, described as being from 5% to 10% the size of comparable wet type equipment. Test figures show that it has an efficiency of 99-plus percent in collecting dust particles of 5-mu or greater.



Joy Microdyne

The dust-laden air or gas enters the unit at its mixer section, where each dust particle is enveloped in water as it passes through a fine spray. The particles then pass through turning vanes, which impart a helical motion causing centrifugal force, and are thus dynamically separated from the air. The dust-laden water is captured at the periphery of the eliminator section in blind louvres that are connected to a disposal sump at the bottom of the unit. The cleaned air passes out of the eliminator section through straightening vanes which recover energy of rotation thus reducing over-all draft loss.

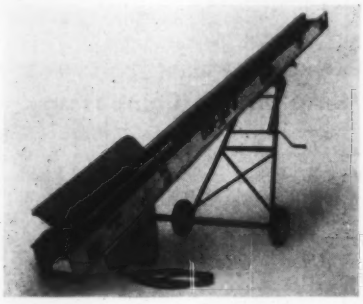
This dust collector can be mounted in existing duct work at the point of use. If sufficient pressure to drive the gases is not available, a vaneaxial fan may be attached to the rear of the unit. **Joy Manufacturing Co., CE 8, Pittsburgh, Pa.**

EQUIPMENT MATERIALS and METHODS

(continued)

Portable Belt Conveyors

THE CON-VAY-IT "T" or troughed belt conveyor has been designed to handle bulk or abrasive materials, such as earth, sand, gravel, rubble, etc. Small boom cross-sectional area permits passage through restricted openings. Standard power mounting is at the conveyor foot end for weight balance. However, head end power is available. The unit, recommended by the manufacturer for small tunnel work, basement excavating, truck loading and unloading, and stock piling, comes in standard lengths of 20-ft, 30-ft, and 40-ft, with electric motor or gasoline engine power and High-Boy elevating frame providing flexibility of application. **American Conveyor Company, CE 8, 2133-37 South Christiana Ave., Chicago 23, Ill.**



Rotary Dryer

A NEW, ALL-WEATHER, drying system for the treatment of sewage sludge and industrial wastes has been developed, wherein the original investment is lower by nearly ½ compared with older style dryers. The system can come on-stream quickly and be shut down smoothly and there is no odor problem. Sewage is not spread over acres of land where drying can be delayed by rainfall.

The basic unit in the compact equipment is a rotary dryer which can handle sludge of 75% to 80% moisture, reducing it to 6% moisture. The product is automatically sized and sent to the bagging unit. The fuel supply to the dryer and to the odor control incinerator is under the watch of an electronic temperature control. Both burners are ignited by remote push button located in the panel board and are equipped with combustion safeguards which cut off the burner when an unsafe condition exists.

(Continued on page 126)

Kinnear Steel Rolling Grilles
CONTROL SPACE

without blocking light, air, sound or vision

Coils Out of View When Not in Use! Artistic, modern beauty and great strength *plus space-saving convenience!* Kinnear Rolling Grilles are ideal for "space control" — closing off corridors, bays, or other room areas. Curtain of heavy round bars locked in rugged steel links defies burglars, trespassers, vandals. Coils upward, stays out of view until closed and locked. Heavily galvanized for lasting beauty (aluminum or bronze also available). For face-of-wall or under-lintel mounting. Any size. Manual or motor control. Send for full information.

KINNEAR Rolling Counter Shutters Also Provide Space-Saving Protection

The counter shutter that coils upward, completely out of the way! Protects with a rugged all-metal curtain when lowered. Made like the famous Kinnear Steel Rolling Doors used so widely in service openings of all types, but with a curtain of one of Kinnear's "midget" slats. For all counter openings up to 20' wide. Steel, aluminum, bronze, or stainless steel. Write for details.

The KINNEAR Mfg. Co.
FACTORIES:
1080-90 Fields Avenue, Columbus 16, Ohio
1742 Yosemite Ave., San Francisco 24, Calif.

KINNEAR
ROLLING DOORS
Saving Ways in Doorways

A saleable product of uniform particle size, friable and non-dusty is obtained. It can be treated to definite pH (by adding ferrous sulphate to lower pH or lime to raise it) and can be improved as a fertilizer by adding nitrogen and phosphorous. The dryer serves as an excellent mixer and the sludge is a good carrier of additives because of its bulky nature. **Standard Steel Corp., CE 8, 5001 South Boyle Ave., Los Angeles 58, Calif.**

Trailer Dump

A NEW 30-CU YD TANDEM AXLE trailer dump, known as Model STMF Transporter, has been designed for economical bulk materials hauling in areas where highway weight limit laws set a medium gross weight limit and allow credit for only one set of tandem axles.

Intended for use with single rear axle tractors, it is fitted with a front-mounted Uni-scopic single cylinder telescopic hoist which shifts hoist weight forward onto the tractor axles, allowing additional loading of the trailer axles and increased payloads, and can be used for direct dumping into road surfacing machines.

Ten gauge high resistant steel is used throughout the body. The chassis is supplied with tandem Stabl-ride or center pivot bridge type suspension. Understructure consists of closely spaced 4-in. channel crossmembers gusseted and welded to 6-in. I-beam longitudinals. A full selection of axle capacities, brake types, tires, etc. is offered. **Galion Allsteel Body Co., CE 8, Galion, Ohio.**

EASY TO
INSTALL CUTTING-IN
VALVES FOR BETTER
CONTROL
MH
MECHANICAL JOINT
M & H Cutting-In Valves and Cutting-In Sleeves have mechanical joints designed to work with various classes of cast iron pipe. By cutting a short section of correct length out of an existing pipe line, the Sleeve and Valve are easily installed by unskilled workmen. The Cutting-In Valve is the same design, construction and materials as M & H A.W.W.A., double disc gate valves, except for the mechanical joint and connections designed to work with various outside diameters of different classes of pipe. These valves are available with O-Ring seal or conventional stuffing box. Sizes, 4" through 12". Write or phone for details.
M&H VALVE
AND FITTINGS COMPANY
ANNISTON, ALABAMA
SUBSIDIARY OF
W
WALWORTH

Automatic Computing

AUTOMATIC COMPUTING methods have been adopted in connection with the design of roof trusses. Plans are being made to explore the use of electronic computers in the solution of other engineering problems as this method permits more creative use of engineers' time, much of which is spent in compiling repetitive tabular information. In 15-min, an IBM Type 650 magnetic drum data processing machine processed as much truss loading data as one engineer could prepare in 2 months. Programming for this use of the computer was worked out by Edward K. Strand, staff engineer. **Austin Co., Engineers and Builders, CE 8, Cleveland, Ohio.**

New Plastic Pipe

PRODUCTION OF THE SP PLASTIC PIPE, manufactured from a new-type polyethylene resin and demonstrating higher working pressures, superior temperature resistance and the absence of stress cracking, is expected to expand the acceptance of plastic pipe for water service and industrial applications. These properties are ascribed to the high molecular weight and structure of the polyethylene molecule. Failure due to environmental stress cracking is entirely overcome. **Orangeburg Manufacturing Co., CE 8, Orangeburg, N. Y.**

Aluminum Coupling Tool

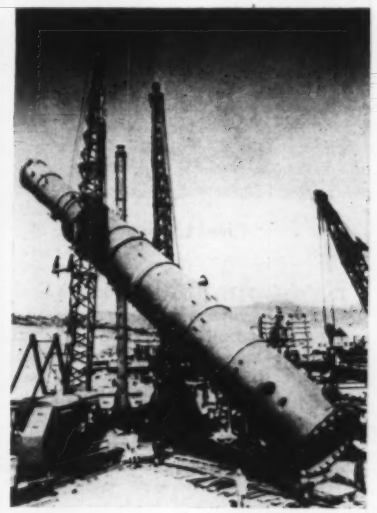
NO SPECIAL SKILL is required for making on-the-job aluminum line-pipe connections with the Fast Move Coupler attaching tool.

The new coupling tool is portable, simple to operate and designed especially for those who require custom infield installation.

Four steps are required for attaching Fast Move Couplers on-the-job: (1) Place pipe in saddle of flanging tool (2) Flip cam-action locking device and position coupler (3) Turn ratchet-type handle clockwise to automatic stop (4) Release cam-action locking device and coupler is securely attached to pipe. **Industrial Dept., John Bean Div., Food Machinery & Chemical Corp., CE 8, San Jose, Calif.**

Tower

A REFINERY LOGISTICS problem was solved because of the gas-tight internal construction of an atmospheric tower which allows it to remain afloat. Prefabrication had been recommended by engineers as the best solution to construction problems in an area short of skilled labor.



Lifting the Tower

The tower of the 20,000 B/SD crude fractionating unit to Texaco's Santiago Works was used as its own landing ship, towed ashore by a tug and lifted from the water by two cranes. Final erection was done by three cranes, two lifting the top of the tower and the other inching the base into position.

The 103-ft long tower is 10-ft, 6-in. in diam at the base and 7-ft at the top. **Procon Inc., CE 8, 1111 Mt. Prospect Road, Des Plaines, Ill.**

Welding Head Manipulator

THE NEW MODEL 12 x 12 RBM Series Manipulator is equipped with a cat walk which allows inspection personnel access to weld operation during actual welding on large diameter tanks. Inspectors can climb onto the catwalk at any time, impossible when the operator is riding in the pulpit usually supplied.

The manipulator is mounted on a self-propelled travel car with 360-deg manual rotation of the column. Welding power source and flux recovery system are mounted on a bracket attached to the column, permitting 360-deg rotation without snarling electrical cables or flux hose. All controls, including tachometer for remote speed indication, are mounted at the end of the boom.

The manipulator is available in 3 different series, with optional extra equipment to meet any special requirement. The catwalk is removable for small diameter work. Power rotation is also available. **Pandjiris Weldment Co., CE 8, 5151 Northorp Ave., St. Louis 10, Mo.**

Vibration Mounts

A LINE OF PAD-TYPE mountings designed especially for an effective, economical solution to vibration problems encountered in the installation of machinery foundations is offered in four densities furnished in sheets of standard size or in specified sizes and shapes. They come in two different styles: Cork-Flex is a natural cork material in mat or panel form; Cork-Rib consists of a core of natural cork with ribbed neoprene faces and is designed for high deflection rates. Load capacities range from 5 to 100-psi. Standard pad thicknesses range from 1-in. to 4-in. **Vibration Mountings, Inc., CE 8, 98-17 50th Ave., Corona 68, L. I.**

With the use of Haven-Busch T-Chord Longspan* Joists you can plan clear, column-free floor areas up to 150' wide. T-Chord Longspan Joists open new vistas for large, uncluttered interiors and offer wide latitudes for planning built-in lighting, insulating and ventilating systems. See our Sweet's File or write for our catalog.

T-Chord Longspan Joists Structural Steel Ornamental Iron

HAVEN-BUSCH COMPANY
DESIGNERS — FABRICATORS — ERECTORS
504 Front Ave., N.W., Grand Rapids, 4, Mich.
SINCE 1888

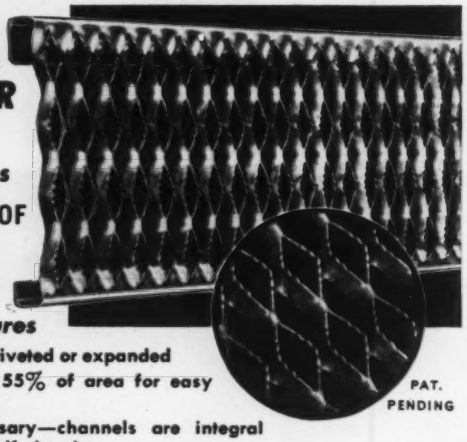
two superior open steel
FLOOR GRATINGS
BY GLOBE

1 Safety GRIP-STRUT®

FOR MAXIMUM SAFETY ALL OVER YOUR PLANT

Important Safety Features

★ FIRE PROOF ★ SLIP PROOF
★ MAXIMUM STRENGTH
★ MINIMUM WEIGHT



Important Economy Features

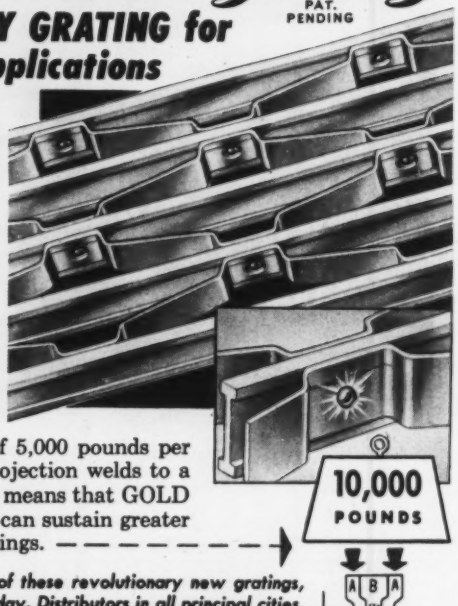
★ All one piece, not welded, riveted or expanded
★ Open space in excess of 55% of area for easy access of light and air
★ No extra supports necessary—channels are integral part of the material. ★ Self cleaning
★ Cut and installed like lumber by your own maintenance force. ★ Low in original cost. ★ For balconies, no secondary sprinkler heads needed

Ideal for work platforms, stair and ladder steps, flooring, balconies, catwalks, machinery guards, fire escapes and for original equipment safety treads.

2 GOLD NUGGET® WELDED grating PAT. PENDING

The QUALITY GRATING for Heavy Duty Applications

★ ¾" projection weld nugget for greater rigidity and strength
★ Vertical alignment of the main load bar assured
★ All bars are load carrying bars including secondary bars
★ Anti-skid pattern



PROJECTION WELD

Each secondary load bar (A), as projected welded to the primary load bar (B) has a shear strength of 5,000 pounds per weld. There are 28 such projection welds to a square foot of grating. This means that GOLD NUGGET Welded Grating can sustain greater shock loads than other gratings.

For the complete details of these revolutionary new gratings, write for new catalogs today. Distributors in all principal cities. Consult the yellow pages in your phone book under "GRATING".

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PRODUCTS DIVISION
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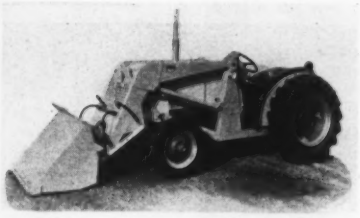
EQUIPMENT MATERIALS and METHODS

(continued)

Hydraulic Loader

A "FIFTH CYLINDER" automatic bucket leveling device is one of the features of the new "Chief" hydraulic loader. Mounted on the left frame support, the "Fifth Cylinder" replaces old style, troublesome linkage principle, allowing the operator more freedom. The 12-gpm hydraulic system lifts 1750-lbs to full height in 6-sec and down in 3-sec.



Chief Loader

The rugged steel box frame is electric welded to form a single shock-resisting unit, offering full view operation and convenient step-on side mount design. There are chromed hi-carbon steel rods and double-acting cylinders throughout with fingertip control of all hydraulics. **Henderson Manufacturing Co., CE 8, Cedar Rapids, Iowa.**

Masonry Drilling Machine

A NEW CORE DRILLING UNIT, known as "The Hustler," is used to cut holes in existing floors or walls for conduit and piping or to extract test cores of highways and buildings for laboratory analysis, replacing jack hammers or carbide drilling.

Using surface-set diamond or diamond impregnated coring bits, available in ¼-in. to 6½-in. diam, the unit drills through cement block at a rate of 1-min per ft or reinforced concrete aggregate at 5 to 8-min per ft.

The basic unit weighs only 80-lbs and is adaptable to any air or electrical motor. Heavy-duty or medium-duty electrical motors in speed ranges from 250 to 1000 RPM are also supplied. The feed mechanism is a rack and pinion arrangement with a travel of 28-in. Provision is made for attaching the unit to walls to make it self-supporting in horizontal drilling operations. **Diamond Products, Inc., CE 8, 418 Prospect St., Elyria, Ohio.**

EQUIPMENT MATERIALS and METHODS

(continued)

Industrial Lift Truck

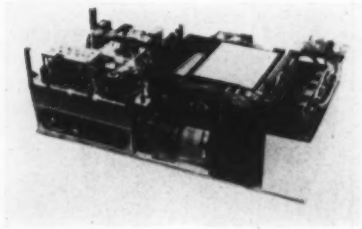
THE COMPLETION OF THE world's heaviest capacity industrial lift truck, a high lift diesel electric platform model capable of handling loads up to 200,000-lb loads, has been announced.

21-ft 4-in. long, its total weight is 77,000-lbs. Its die carrying platform measures 13-ft by 18-ft. The truck is designed to handle huge dies, expediting their transit between outside storage and inside presses and to provide 2-ft 4-in. of lift hydraulically. It is driven by four 36 in. dia. by 16-in. face drive wheels and steers completely hydraulically through 8 sets of caster wheels.

Despite its tremendous weight and bulk, hydraulic power steering permits the lift truck to be guided with less steering effort than that encountered in an automobile equipped with power steering. **Yale & Towne Manufacturing Co., CE 8, 11,000 Roosevelt Blvd., Philadelphia, Pa.**

Aerial Photography

INSTANT AERIAL PHOTOGRAPHY is now possible with a new automatic device combining electronics and photography. The revolutionary device, which consists of a radar strip recorder and fast film processor, takes a photo of the ground beneath the plane and develops it instantly. Working equally well day or night, above clouds or in clear weather, the system is said to combine the accuracy of radar, the convenience and utility of photography, and the speed of electronics. In addition to permitting navigation to pinpoint accuracy, the system has important engineering applications requiring aerial mapping. Both civilian and military telemetering systems are expected to utilize the rapid, permanent readout features of the processor. Electronic computers can also make efficient use of the up-to-the-minute, yet permanent, recording characteristics of the machine. **Hycon Mfg. Co., CE 8, Pasadena, Calif.**



"Instant Radar Maps"

NOW Low-Cost Automatic Flow Recording

STEVENS Type F Recorder

For Measuring Sewage, Industrial Waste and Other Flows

Flow charts directly readable in million gallons per day or gallons per minute over various sizes of Parshall flumes. The same recorder can also be used with charts reading in feet and hundredths to record head or surface fluctuations in lakes, streams and wells. Priced from $132. Write for free Bulletin 24.

The planning and efficient operation of any project which involves measurement of flowing liquids is based on flow data which can be obtained with STEVENS Water Level Recorders. STEVENS instruments are at work compiling data on hydroelectric and flood control projects and in water works, sewage disposal plants, irrigation and industrial installations in all parts of the world.

Experienced technical staff available for consultation on any liquid measurement installation. Write, giving description of project, and scope of data desired.

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144 pages of technical data on recorder installations, plus a wealth of hydraulic tables and conversion tables. $1.00 each. (No COD's.)

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Please rush_____copies of the STEVENS DATA BOOK for which I enclose $1.00 each.

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Larger Tubing Spring Clip

TUBING SPRING CLIPS, designed for industrial, air-conditioning and electrical installations to hold conduit, wiring, cable, hose, etc. to ducts and building surfaces, are now available in a larger, ⅜-in. size. This new size has the same holding qualities of the smaller, which is ¼-in., but enables builders and contractors to use larger diameter wire and tubing materials for faster, time-saving installations. Application to a surface base of the adhesive-covered clip is all that is required for swift attachment. This adhesive bond increases to a maximum tested holding strength of 75-lbs per clip. **Stic-Klip ® Manufacturing Co., CE 8, 500 Regent St., Cambridge 40, Mass.**

Scalemaster

NEW IMPROVED 12-IN. Architects and Engineers Scalemasters have been introduced recently. The new Scalemasters have metal reinforcements on each end to give them greater rigidity.

Other important features are: all scales exposed to full view for use at a moment's notice; slotted openings for convenient use; squinting, searching or turning to find needed scale is eliminated with a resultant saving of time and effort.

The Architects' Scalemaster has 14 full view exposed scales, and the Engineers' Scalemaster has 9 full view exposed scales. **The C-Thru Ruler Co., CE 8, 827 Windsor St., Hartford, Conn.**

Sealed Register Water Meter

AMONG THE MANY IMPORTANT features of this oscillating piston meter are: a hermetically sealed register to prevent condensation and keep out water and dirt; a heat treated glass to stop breakage; magnetic drive, reducing drag on the measuring chamber; an "O"-ring gasket which is molded into the bottom plate liner and provides positive seal; an interchangeable bottom plate; a cast bronze case with full flow passageways; a cylindrical strainer with a large area for unrestricted flow.

The piston and the piston roller are the only moving parts in the flowing stream, both readily accessible and economical to replace in case of corrosion. The meter is a simple assembly of relatively few parts that fit together in an easily understood pattern. **Rockwell Manufacturing Co., CE 8, 400 N. Lexington Ave., Pittsburgh 8, Pa.**

Truck Crane Improvements

FORMERLY A 35-TON machine, the 43-M truck crane now has a rated lifting capacity of 40-tons at an operating radius of 12-ft. Among the new features is an improvement of the power up-power down boom hoist, which lowers the boom at one-half the raising speed at any given engine speed, and allows the operator to spot the load safely and accurately. Carrier outriggers are on rollers for fast and easy setting and light-weight aluminum floats have been added as standard equipment. The gantry has been re-designed to improve the lead on the cable to give straight line reeving and obtain smooth wrapping of cable on the drum. **Marion Power Shovel Co., CE 8, Marion, Ohio.**

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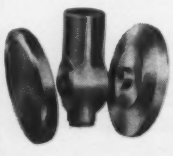
GATE VALVES

First Choice for Extreme Reliability

Because of their inaccessibility underground, repairs to gate valves are always time-consuming, expensive, and a source of annoyance. And interruptions in service while repairs go on are hazardous for the community.

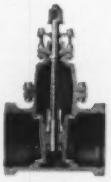
For these reasons, R. D. Wood Gate Valves are designed to function for generations no matter what the conditions. They are rugged in construction, fully bronze mounted, and tested to 300 lb. hydrostatic pressure. Designed for working pressures conforming to AWWA specifications.

Available with mechanical joint or flange-type pipe connection



SIMPLE IN DESIGN

Only three moving parts—a spreader and two discs which are free to revolve their complete circumference while being raised or lowered. Gates are lifted entirely clear of valve openings, providing unobstructed flow.



(continued)

Belt Clamps

A FAST, EASY WAY OF INSTALLING conveyor belts, considered by many as revolutionary, obsoletes former methods because it does the job much quicker than was heretofore possible and with far less effort. The equipment, known as the Far-Pul, is light in weight by contrast and employs fast-acting jacks in place of slow, unwieldy take-up screws. Belt down-time is reduced to a minimum, an important advantage in today's operations.

Here's how the time-saving Far-Pul works. Each end of the belt is clamped between bars, one set of which is equipped with jacks and tensioning rods. The tensioning rods are slipped over studs on the opposite bar clamp. The ends of the belt are drawn together by the jacks. When fasteners mesh properly, pin is inserted through loops of lacing or fasteners. Tension on jacks is released, clamps are removed from belt and belt is ready to operate.

This belt clamp is easily operated by one man, a wrench is the only tool needed. It pulls to fractions of an inch and keeps belts in perfect alignment. All-steel construction assures durability. Requires very little space for storage when not in use. **Flexible Steel Lacing Co., CE 8, 4607 Lexington St., Chicago 44, Ill.**

R. D. Wood Gate Valves also now available with O-Ring Stuffing Box seal when specified.

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R. D. WOOD COMPANY

Public Ledger Building, Independence Square, Philadelphia 5, Pa.

Manufacturers of Mathews Hydrants and "Sand-Spun" Pipe (centrifugally cast in sand molds)

Jib Crane

A BASE MOUNTED JIB crane, recently developed, features a specially designed, heavy duty beam support bearing which provides safe load support while requiring a minimum of maintenance. The bearing consists of a large tapered roller bearing located at the top of the support column. Below are a pair of steel rollers which bear on a wear band welded to the column. These rollers are mounted on anti-friction bearings and are fully adjustable. The exclusive adjustment feature permits fast accurate leveling of the crane beam without the use of shims. Basic construction of the crane is such that the total beam deflection under full load does not exceed .060-in. per ft. The unit bolts to a suitable foundation and is not dependent on external structural members for support. **Becker Crane & Conveyor Co., CE 8, 4900 Ridge Road, Cleveland 9, Ohio.**

Catalytic Exhaust Purifier

A 1½-TON UNDERGROUND diesel locomotive for mining and tunnel work, with fumes from its engine exhaust removed by a catalytic purifier, has been added to the line being manufactured by the Hack Co.

The purifier, known as the Dieseler, has proved itself an effective means of reducing noxious and irritating exhaust fumes of 4-cycle diesel engines. It attaches directly to the exhaust manifold. The purified gases from the Dieseler are piped through a water-filled tank where they are cooled off. Laboratory tests on Dieseler-equipped engines which have been loaded to simulate the work cycles of trucks, buses, tractors and locomotives prove that the device eliminates 65-85% of irritating hydrocarbons and 80-90% of carbon monoxide. They can be installed on any equipment powered with 4-cycle diesel engines to permit their use underground or indoors without danger from exhaust fumes. **Oxy-Catalyst, Inc., CE 8, Wayne, Pa.**

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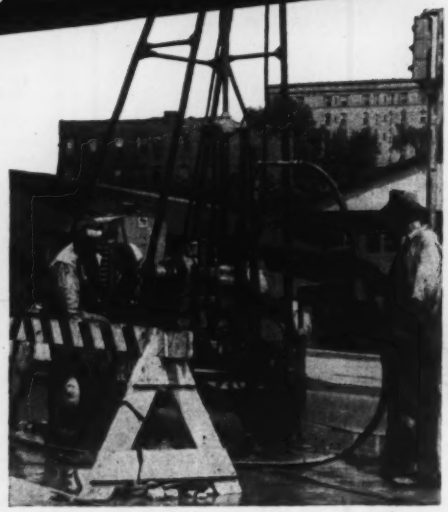

When it's better to be safe than sorry, engineers investigate underground conditions. And, that's exactly what this Acker TH drill is doing — drilling test holes over a walled-up section of the old Erie Canal preparatory to building an overhead express highway.

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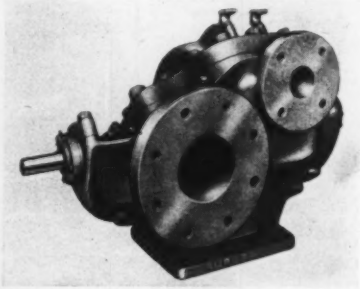
EQUIPMENT MATERIALS and METHODS

(continued)

Centrifugal Pumps

A LINE OF DIAGONALLY split case centrifugal pumps has been developed, suited to many applications, important among which is boiler feed service as well as hot or volatile liquids applications requiring low NPSH characteristics.

These pumps, while retaining the advantages of the horizontally split case pumps embody advantages inherent in the 45-deg. casing split. The features, in common with horizontally split case pumps, are ability to remove the entire rotating element without disturbing the piping or the pump-motor-base alignment. The 45-deg split allows both suction and discharge to be in the bottom half of the casing but above the center line of the pump. These pumps are self-venting and will not vapor lock—thus the need for bleeding back to the feed water heater or the receiver is eliminated. Large suction areas give ideal NPSH characteristics.



Diagonally Split Case

Available in water cooled stuffing box and water cooled bearing construction when required. These type AJ pumps have as standard, 125# A.S.A. suction flange and 250# A.S.A. discharge flange—and are usually bronze-fitted but can be furnished all-iron or stainless steel trim for high temperature conditions. **Aurora Pump Division, The New York Air Brake Co., CE 8, 57 Loucks Street, Aurora, Ill.**

British Seismograph

THE WATTS WILLMORE Pattern Seismograph, developed by the University of Cambridge, England, is now available in the U. S.

Portable, it records for up to 24-hrs at 60mm per min, with needle-sharp definition, and is designed for a variety of geophysical applications, including blast

recording, rockburst studies, study of earth shocks related to volcanic activity and teleseismic work.

The unit is sealed in a waterproof, metal case which permits burial in open ground, and is easily convertible from horizontal to vertical operation. The self-contained recorder unit operates on any level surface, in full daylight, and features a built-in calibrator and step attenuators which provide known response characteristics at all frequencies. **Information Service, Jarrell-Ash Co., CE 8, 26 Farwell St., Newtonville 60, Mass.**

New Motors

A COMPLETE LINE of masonry saws, including the All New 2 hp Supermatic, and the 1½ hp Select-A-Notch, now feature specially designed G.E. motors. Capacitor run, capacitor start motors that require up to 20% less amperage than ordinary type masonry saw motors, they develop power several times greater than the nominal rating of G.E. motors. The rotors are treated with Dry-Film, a silicone coating used to protect the rotor from moisture. This prevents condensation or seepage from causing electrical shorts or grounds. An advanced lubrication system is used, which requires less maintenance. The grease is a new type that has 3 times more the operating life of ordinary greases, and is extraordinarily resistant to oxidation. Special centrifugal mechanism and switch is also provided. **Clipper Mfg. Co., CE 8, 2800 Warwick, Kansas City 8, Mo.**

End-Loader Sweeper

A NEW END-LOADER sweeper has been developed, which can be mounted on the front of any tractor end-loader and has a left hand drive permitting sweeping in gutters and near the curb. The arms of Model EL-C can be raised while the brush is rotating. Speed rotation of the brush is constant and entirely independent of the prime mover. Brush lengths of 6 or 7-ft are available. The brush can be turned end-for-end to give even wear.

The sweeper comes equipped with an independent engine, a choice of either a Wisconsin 7 hp AEN or a Wisconsin 14 hp TH. The same pins that hold the bucket are used to hold the sweeper which can be mounted or dismounted in minutes. Optional equipment include a front deflector for wind-row sweeping and a sprinkling system and water tank (to keep dust at a minimum). **Little Giant Products, Inc., CE 8, 1530-50 N. E. Adams Street, Peoria, Ill.**

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regardless of velocity

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For open channels in industrial plants, waterworks, irrigation systems, and sewage disposal plants. Easy to read. Self-cleaning. Low head loss. Galvanized steel. Throat widths 3" to 10'.

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Many hours of tedious computations can be saved by using ASCE Manual 31 in the design of concrete shell roofs. The charts and tables that are contained in this 177-page Manual yield final moments and forces by simple slide-rule operations. The most complicated arrangements can be designed safely and surely in a matter of hours. One can also determine such variables as chord width, span length, thickness, and curvature of shells. The revisions that have been incorporated in this latest printing make the work even easier than before. This Manual can be ordered by clipping this coupon and remitting as indicated below.

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HYDRAULICS TRANSLATIONS

To avoid duplication of effort and to bring the hydraulics engineer a definitive list of available translations of literature on hydraulics, the Committee on Research of the Hydraulics Division has prepared "A List of Translations of Foreign Literature on Hydraulics." This material is available as ASCE Manual 35—the latest of a renowned series of authoritative publications on civil-engineering subjects. This Manual can be ordered by clipping this coupon and remitting as indicated below.

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MANUAL 10 REVISED
CITY SURVEYING PROCEDURE STANDARDIZED

In any community, large or small, boundaries of the original land subdivisions form the basis of all subsequent property subdivisions. Thus, the need for a complete and somewhat standard "city survey" is essential to the successful operation or expansion of any community. Recognizing this very important need, Manual 10 was originally written, and has now been revised, for the purpose of describing the various divisions of a city survey, to furnish specifications for it, and to make recommendations as to accepted technical procedures. The new Manual 10 contains revised chapters on such basic topics as Triangulation, Traversing, Leveling, Topography, and Property Surveying; a new chapter devoted to the ever-growing field of Photogrammetry; and a new Appendix containing the different types of maps used in city planning.

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Literature Available

FIRE PROTECTION—"How Investment in Fire Protection Pays Dividends" is the title of a new 8-page, 2-color, illustrated booklet. Bulletin 78 explains how an investment in automatic sprinkler protection can amortize itself out of insurance savings and bring many other economic benefits. Also included are actual examples of systems which paid for themselves in from 2½ to 8 years. **"Automatic" Sprinkler Corp. of America, CE 8, Youngstown 1, Ohio.**

NUCLEAR ENGINEERING—How $400 million in coin silver weighing 14,000 tons were borrowed from the U. S. Treasury for use as electrical conductors at the atomic energy plant in Oak Ridge, Tenn., during World War II when copper was scarce, is told in a new, 36-page, illustrated booklet entitled "Engineering for Atomic Power." **Stone & Webster Engineering Corp., CE 8, 49 Federal St., Boston, Mass.**

TRACTORS—A new 12-page booklet, "Ford Tractors and Their Industrial Applications" profusely illustrated, shows Ford Tractors and industrial equipment in action. Containing abbreviated specifications of all equipment, copies are available on request from **Industrial Sales Dept., Tractor and Implement Div., Ford Motor Co., CE 8, 2500 E. Maple Road, Birmingham, Mich.**

IMPROVED CONCRETE PAVER—Significant design changes in the Multifoote Concrete Paver include hydraulic controls, a new low clearance, faster skip operation, improved bucket operation, and lower maintenance. Five small levers, conveniently located for the operator, hydraulically control the A-frame, skip support bracket, batch transfer, discharge chute and bucket opening. Multifoote Bulletin No. 2616 is available upon request. **Construction Equipment Div., Blaw-Knox Co., CE 8, Mattoon, Ill.**

WATER CONTROL—A problem common to city and highway engineers, that is the conveyance of water, either to or from a given point, is discussed in a new, 4-page bulletin. Typical ditches and channels used for water control are illustrated and a "right" and "wrong" example of such jobs is also shown. The title of the publication is "Water Control with Gunite" and it is available upon request to **Gunite Contractors Association, CE 8, 714 West Olympic Blvd., Los Angeles 15, Calif.**

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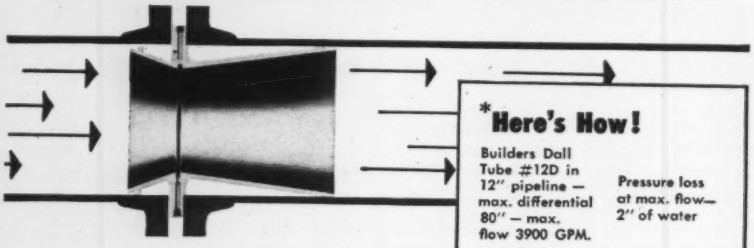

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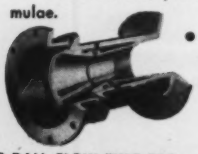

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Literature Available

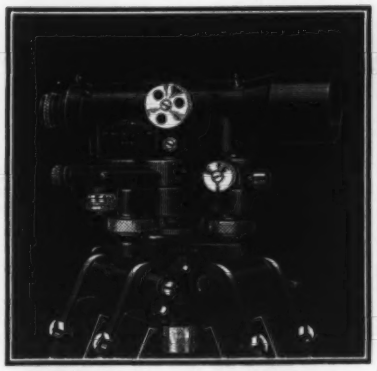
LUBRICATING OIL—"Have You Been Around When Your Engine's Torn Down" is the title of a new 8-page, 2-color booklet which explains the functions of detergent oils and their relation to filter elements. Cutaway views of these elements are used to show components and diagram lubricating oil flow, while drawings and photographs illustrate the effects of varnishes, sludge and abrasive particles on critical engine parts. Also illustrated is a historical presentation of filter development from the metal strainer type to the modern plastic-impregnated paper element. Write for form DE732. **Caterpillar Tractor Co., CE 8, Peoria, Ill.**

SPRAY RIG—Catalog No. W-64 tells how your pickup can be quickly and simply adapted to roadside weed and brush control, so as to have a faster, more convenient one-man operation. The Spray Rig Pump is power take-off operated, and the catalog shows how jets can be mounted so that one man drive-spraying is possible with cab control. Hand gun spraying is also shown. The mounting of this spray rig in no way changes the basic use and appearance of the pickup. **H. S. Watson Co., CE 8, 1316—67th St., Oakland 8, Calif.**

WATERTIGHT MASONRY—"The Design and Specification of Watertight Masonry" is the title of a new 6-page folder. This bulletin, "O.M."-8, outlines 6 considerations in designing tight masonry walls: mortar ingredients and proportioning; compatibility of brick and mortar; control of shrinkage and bleeding; separation cracks; effect of mechanical disturbance; importance of proper protection. **The Master Builders Co., CE 8, 7016 Euclid Ave., Cleveland 3, Ohio.**

WATERSTOPS—A new catalog sheet of Labyrinth Waterstops has recently been issued. Blueprint type specification drawings include the labyrinth, flextrip, cellular and dumbbell waterstops in their various sizes. A convenient table lists the recommended joint application and water head for each size and kind of waterstop. **Water Seals, Inc., CE 8, 9 S. Clinton St., Chicago 6, Ill.**

NEW CLAY PIPE—A completely illustrated brochure for engineers, architects, contractors and builders offers information on the qualities of vitrified clay pipe with the new Wedge-Lock plastic joint that snaps together instantly. This file-size, 2-color, 4-page brochure also details the mechanics of Wedge-Lock's total-contact joint, illustrating the simple installation procedure and outlining conditions where it has solved jointing problems. **Robinson Clay Products Co., CE 8, 65 West State St., Akron 9, Ohio.**



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SAFETY CODE—A code covering operation of the powder actuated fastening tool and aimed at insuring maximum safety on the job has been developed. The code was promulgated to serve as a guide to state agencies in the creation of regulations covering use of the tool. A powder actuated tool is one using the power supplied by a fired cartridge to sink a fastener into a variety of non-brittle surfaces, particularly steel and concrete. The code also covers the types of materials which do not lend themselves to powder actuated fastening work and how the fastener should be used and where it should not be used. **Powder Actuated Tool Manufacturers' Institute, Inc., CE 8, 250 East 43rd St., New York 17, N. Y.**

TEMPERATURE CHART—A handy, 8½-in. by 3½-in. temperature conversion chart is again being offered without obligation to engineers, students and others having frequent occasion to convert from one temperature to the other. The easy-to-read tables of Fahrenheit and Centigrade temperature equivalents proved an invaluable time saver to the many who responded to the first offer several years ago. The chart can be easily carried in pocket or wallet, or placed under glass desk tops for easy reference. **Moeller Instrument Co., CE 8, Richmond Hill 18, New York.**

CEMENT MORTAR—A new booklet "Lumnite Cement Mortar Manual—Gun-Applied Linings–Masonry" has just been published. The new manual contains complete information on mortar preparation, placing procedure, and general instructions for gun-applied linings in oil refineries, power plants, metal and similar industries. An appendex offers information on selected aggregates, thermal conductivities of Lumnite concretes, and strength curves. A bibliography on refractory concrete has been included for easy reference. **Universal Atlas Cement Co., CE 8, 100 Park Avenue, New York 17, New York.**

FABRICATION SERVICE—The important services being rendered to American industry by specialized custom fabrication is the subject of a new brochure. Many tons of customers' blueprints are processed each year by the company's engineering department as a part of its service, according to the brochure. There is a description of company facilities for working all types of metals. Products many companies would find prohibitively expensive to produce themselves are made at low unit costs on a production run basis. Prototypes or one-of-a-kind products are also specialties of the organization. **Tornqvist Company, CE 8, 521 Crooks Avenue, Clifton, N. J.**

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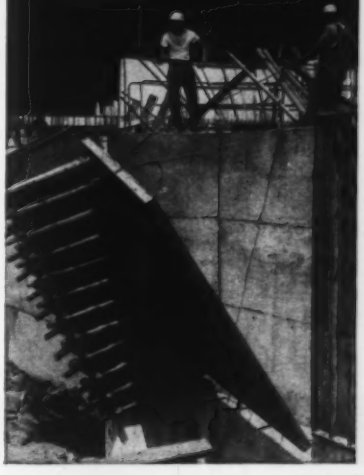

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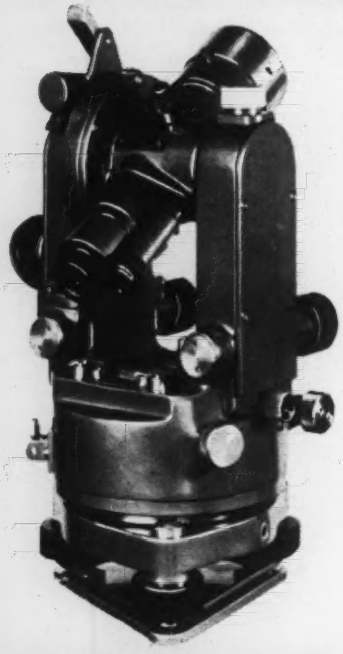

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NAME CHANGE: Bros Inc. is the new name of the Wm. Bros & Mfg. Co., Minneapolis, Minn., which is observing its 75th Anniversary . . . **NEW MAGAZINE:** The "Gar Wood-Buckeye Construction News" will be published quarterly by Gar Wood Industries, Inc., Wayne, Mich. It will feature interesting construction techniques, explanations of unusual equipment applications and a regular service feature . . . **POLYCARBONATE TECHNOLOGY:** A new plastic material, which is expected to replace cast metals, ceramics and other plastics in many applications, has been developed by General Electric, Pittsfield, Mass. Parts made from the compound, Lexan polycarbonate resin, are reportedly strong enough to withstand the blows of a carpenter's hammer . . . **FOREIGN INSTRUMENTS:** Precision Instruments, Inc., which will import and distribute instruments of foreign manufacture that are non-competitive with those of domestic make, has been formed in Troy, N. Y. . . . **6000TH LOCOMOTIVE:** Delivery of a 20-ton Diesel to Anaconda Copper's Chile Exploration Co. marks the 6000th locomotive built by the Fate-Root-Heath Co., Plymouth, Ohio . . . **PROFIT INCREASE:** Net income of Raymond Concrete Pile Co., international foundation and heavy construction firm, in 1956 increased 46% over 1955, resulting from a 36% greater volume of completed work . . . **NEW SUBSIDIARIES:** The Allis-Chalmers Mfg. Co., Milwaukee, has established the Allis-Chalmers Australia Pty. Ltd. in Australia where the company will be in a stronger position in a growing market for construction machinery outside the U. S. . . . Universal Form Clamp Co., Chicago, has opened Canada, Ltd. at Toronto, Ont. J. D. Livingston, formerly with Livingston-Goehring, Ltd., will be manager . . . **RESEARCH PROGRAM:** The Tapecoat Co., Evanston, Ill., originators of coal-tar coating in tape form, has established a separate research and development department which will investigate protective pipe coatings, paints, anti-corrosion agents and the application of these products . . . **NEW PLANT:** A 100% expansion and remodeling program of the Detroit plant of Massey-Harris-Ferguson, Inc., manufacturers of wheel tractors for construction, general industry and related fields, has begun. The new plant will nearly double the company's Detroit working force . . . **APPOINTMENTS:** Paul D. Smith has been named President of Intrusion-Prepakt, Inc., succeeding retiring company founder Louis S. Wertz . . . Earl A. Frazier has been appointed N. Y. district sales manager for the Wire Rope and Aircord Division of John A. Roebling's Sons Corp. . . . T. Ray Johnson is now Vice-President in charge of Sales at W. R. Meadows Inc.

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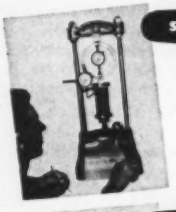

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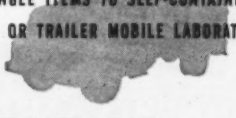

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July

1289. Mississippi Valley Geology—Its Engineering Significance, by C. R. Kolb and W. G. Shockley. (SM) The increasing importance of geologic information to the design of engineering structures in the lower Mississippi River valley is pointed out. The various environments of alluvial deposition and the resulting soil formations are discussed, especially with relation to engineering problems associated with them.

1290. Deflections of Structures in the Inelastic Range, by Kurt H. Gerstle. (EM) An approach to the problem of finding deflections of structures of perfectly plastic material in the inelastic range is developed. Charts relating loads and deformations of rectangular beams are furnished and may be used to analyze indeterminate structures composed of members of such cross sections in the inelastic range.

1291. Lateral Buckling of I-Beams Subjected to Unequal End Moments, by J. W. Clark, Jr. and J. R. Jombock, Jr. (EM) An experimental investigation into elastic and inelastic lateral buckling of aluminum alloy I-beams subjected to unequal end moments is reported. An approximate method is presented for determining the inelastic buckling strength of I-beams with this type of loading. Suggestions are made by which nonuniform bending could be handled more accurately in present design specifications.

1292. The Lateral Rigidity of Suspension Bridges, by I. K. Silverman. (EM) The behavior of a suspended structure under lateral loads is shown to depend on the values of three dimensionless parameters. The spring constant for small vibrations in the horizontal plane is also derived.

1293. Buckling of Plates Under Non-Homogeneous Stress, by P. P. Bijlaard. (EM) Plastic buckling stresses are calculated for long clamped plates, clamped flanges, and hinged flanges, all subjected to longitudinal bending or eccentric compression in their plane. Simple design formulas and graphs are presented for the plastic reduction factor to be applied to the associated elastic cases.

1294. Location Needs to Get Full Benefits from Freeways, by R. N. Grunow. (HW) It is shown that freeways should be located to best serve traffic demands. General locations can be determined by the techniques of origin-destination studies.

1295. Freeway Benefits, by Terry J. Owens. (HW) This paper demonstrates that from every angle of measurement freeways have benefits which justify their construction. Fatality rates are only half and accident rates only a fifth of those on important surface arteries. Time and dollar savings are generally substantial on freeways. It is also shown that freeways increase property value and stimulate residential and industrial development.

1296. The Planning Role in Pittsburgh's Penn-Lincoln Parkway, by William R. B. Froehlich. (HW) This paper outlines the role of city planners and planning agencies in the development of the new Pittsburgh Renaissance. It describes in detail the background and planning of the Penn-Lincoln Parkway, Pittsburgh's east-west expressway.

1297. Tests to Evaluate Concrete Pavement Subbases, by L. D. Childs, B. E. Colley, and J. W. Kapernick. (HW) It is shown that concrete pavement slabs on dense graded granular subbases developed smaller strains, deflections, and subgrade pressures under test loads than slabs directly on clay subgrades. Thin subbases, 6 in. or less, reduced deflections more effectively per unit thickness than thicker subbases.

1298. Highway Planning, by E. H. Holmes and J. T. Lynch. (HW) Highway planning has been carried out jointly by the Bureau of Public Roads and the State Highway departments throughout the past twenty years. Facts affecting state and federal legislation have been assembled. Methods must be perfected for keeping the needs studies current and projecting them into the future.

1299. Dewatering Miami's Biscayne Aquifer, by Byron J. Prugh. (SM) This paper describes the use of wellpoints in dewatering a major excavation penetrating deep into the Biscayne Aquifer through the Miami oolite and the soils encountered.

1300. Horizontal Drains on California Highways, by T. W. Smith and G. V. Stafford. (SM) A discussion is presented of changes in methods of installation, development of equipment, and engineering aspects of horizontal drains on California highways in the light of sixteen years of experience and thousands of feet of drains installed.

1301. A Review of the Theories for Sand Drains, by F. E. Richart, Jr. (SM) This paper presents available theories for sand drains with regard to assumptions and limitations. Effectiveness of small-diameter "ideal" wells is illustrated, and use of numerical procedures for consolidation problems is also discussed.

1302. Vehicle Loads and Highway Bridge Design, by Stewart Mitchell and Gerald F. Berrmann. (ST) This paper analyzes inconsistencies which appear when highway bridges of different types are rated for overload capacity. Capacities in relation to maximum live loads and frequency of heavy load applications in actual service are considered, and recommendations concerning choice of design loads are offered.

1303. Distribution of Loads on Bridge Decks, by A. M. Lount. (ST) This paper examines recent developments in computation techniques as applied to determination of load distribution between longitudinal members of bridges. The action of diaphragms and their beneficial effects and economy are emphasized.

1304. Fatigue Resistance of Prestressed Concrete Beams in Bending, by C. E. Ekberg, R. E. Walther, and R. G. Slutter. (ST) A method is presented to predict fatigue strength of prestressed concrete based on the failure envelope of materials involved. A discussion of factors influencing fatigue strength, such as percentage of steel, level of prestress, and ratio of dead to live load, is also included. Recommendations are given on safety factors for prestressed concrete under fatigue loading.

1303. Research and New Developments in Photogrammetry, by C. L. Miller. (SU) Significant advances in photogrammetry during the past five years and current research programs of importance to civil engineers are discussed in this paper. New advances toward goals of higher precision, time and cost reductions, and new applications are outlined. The M. I. T. research program on photogrammetry and highway engineering is summarized.

1306. Progress Report of the Committee on Highway and Bridge Surveys, Surveying and Mapping Division: Foreward to Manual on Highway and Bridge Surveys and Chapter I—State Plane Coordinates. (ST) This paper which

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is the first in a series that will comprise a new society manual on Highway and Bridge Surveys shows the importance of basing highway surveys on state plane coordinate systems.

1307. New Highways and Photogrammetry, by John G. Ladd. (SU) This article discusses some of the specific advantages of the use of photogrammetric consulting engineers in initial preparation for highway work.

1308. Application of Digital Computers to Bridge Design, by Charles F. Scheffey. (ST) This paper presents a discussion of characteristics of digital computers and the steps necessary to apply them to problems in bridge analysis and design. Recent advances in coding techniques and the potentialities of the computer in more refined analysis and optimization of design are indicated.

1309. Determination of the 0.02 Mm Fraction in Granular Soils, by R. W. Johnson. (SM) This paper describes the method of using statistical analysis to determine the constant representing the ratio of the percent of material finer than .02 mm to the percent passing the No. 200 sieve. Results of tests on twenty-four granular soils are given, together with values for the constant.

1310. Discussions of Proceedings Paper 1064, 1117. (SU) Staley W. Mims, Virgil A. Walston on 1064. Corrections to 1117.

1311. Discussions of Proceedings Papers 1030, 1031, 1138, 1141, 1157. (EM) Peter Price closure to 1030. Corrections to 1031. Lorenz G. Straub, Edward Silberman, Herbert C. Nelson closure to 1031. T. Blench on 1138. T. Au on 1141. John A. Hribar on 1157.

1312. Aluminum Applications in Highway Bridges, by J. M. Pickett. (ST) This paper outlines aluminum alloys used for highway bridges, and reviews the aluminum accessories which are becoming standard usage on conventional bridges.

1313. Selection of the Cross Section for a Composite T-Beam, by R. S. Fountain and I. M. Viest. (ST) The paper discusses a rapid method of selection based on approximate formulas for the section properties.

1314. Highway Bridge Live Loads Based on Laws of Chance, by Henson K. Stephenson. (ST) A new method based on elementary probability theory is presented for estimating live load frequencies on highway bridges. The method will provide a simple mathematical basis for estimating the number of various intensities of stress repetitions produced during the useful life of any given bridge.

1315. Load Factors for Prestressed Concrete Bridges, by T. Y. Lin. (ST) The use of load factors in ultimate design for prestressed concrete bridges is compared to the elastic theory and allowable stress method. Variables affecting the load factor of bridge sections are analyzed, indicating its wide divergence when designed on the basis of no tension in concrete.

1316. Synopsis of First Progress Report of Committee on Factors of Safety, by Oliver G. Julian. (ST) This paper gives definitions, statistical data regarding variations in physical properties of steel and concrete, and tables for correlating factors of safety and probabilities of failure.

1317. Testing Post-Tensioned Slab and Beam without Grouting, by Zachary Sherman. (ST) Two industrial building post-tensioned members were tested in laboratories at the University of Mississippi, at University, in November, 1955. Load versus deflection curves were plotted. Stress diagrams were computed and factors of safety were also determined.

1318. Vibration Susceptibilities of Various Highway Bridge Types, by LeRoy Theodore Oehler. (ST) This paper reports results of deflection and vibration measurements on thirty-four spans of fifteen bridges including simple, continuous, and cantilever type spans.

1319. Discussions of Proceedings Papers 1025, 1026, 1080, 1143, 1145, 1159, 1160, 1161, 1289. (SM) W. A. Clevenger closure to 1025. Nai-Chen Yang closure to 1026. W. G. Shockley and T. B. Goode closure to 1080. Judson P. Elston, Howard P. Hoffman on 1143. Judson P. Elston, Glebe A. Kravetz on 1145. John W. Guinnee and Charles E. Thomas on 1159. Louis P. Menard on 1160. Alfred A. Seymour-Jones, Byron J. Prugh on 1161. Shu-T'Ien Li on 1289.

1320. Applications of AASHO Specifications to Bridge Design, by Eric L. Erickson and Neil Van Eenam. (ST) This paper explains the application of the specifications of the American Association of State Highway Officials (AASHO), paying special attention to the history and development of the various provisions. A section is included covering their application to bridges on the National System of Interstate and Defense Highways. An extensive bibliography is added for reference.

1321. Backfill Guide, by R. B. Peck and H. O. Ireland. (ST) This paper demonstrates the importance of the backfill, points out reasons for specified backfilling procedures, and shows various construction practices that should be avoided.

1322. Dispersion of Longitudinal Waves, by E. Volterra. (EM) Dispersion of longitudinal waves in elastic rods of rectangular cross section is discussed by applying the method of internal constraints. Results given by this theory are compared with those given by other approximate engineering theories, and, in the case of two-dimensional elasticity, with the exact theories given by Lord Rayleigh and Lamb.

1323. Cold Regions Research by the U. S. Corps of Engineers, by Robert R. Philippe. (AT) This paper outlines the Corps of Engineers' (United States Department of the Army) research and development program in the Arctic. Work in progress in Greenland is set forth in detail. Air, surface, and subsurface transport problems are discussed against a background of available materials, power sources, and weather.

1324. Testing of a Compacted Snow Runway, by James A. Bender. (AT) This paper consists of a comprehensive report on the field testing of a snow runway built on the Greenland ice cap by the Corps of Engineers. Test methods and results obtained are set forth in detail.

1325. Aircraft Operations on Floating Ice Sheets, by S. Russell Stearns. (AT) This paper outlines fundamental relations of load and support of a floating ice sheet and extends these concepts to problems of aircraft operations on this medium. The failure mechanism of ice sheets is explained, and limiting load conditions for various failure-stages are indicated. Ice-survey procedure and the effects of variable factors on load capability are carefully set forth.

1326. Airfields on Permafrost, by Kenneth A. Linell. (AT) This paper outlines special problems of constructing airfield pavements on permafrost foundations. Particular attention is devoted to problems of construction in areas of discontinuous permafrost. Importance of non-frost-susceptibility soils is shown, and means of combating degradation of pavements are carefully explained.

1327. White-Out, A Hazard to Arctic Flying, by R. W. Gerdel and M. Diamond. (AT) The studies on Arctic white-out reported in this paper were conducted at a field research station located on the Greenland ice cap. The paper discusses five white-out phenomena, analyzes the possibility of forecasting these phenomena, and suggests methods of dispersal.

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Index To Advertisers

Acker Drill Company, Inc. 132
Air Survey Corporation 21
Allis-Chalmers Manufacturing Company 92
Alster & Associates, Inc. 20
Aluminum Company of America 109
American Bitumuls & Asphalt Company 75
American Bridge Division 9
American-Marietta Company 14
American Pipe & Construction Co. 4
Armco Drainage & Metal Products, Inc. 94
The Asphalt Institute . . . . . 80 and 81

Bethlehem Steel Company . . . . . 22 and 112
Bludworth Marine 134
Borden Metal Products Company 2
Boeing Airplane Company 113
Bros Incorporated 17
Brown & Brown, Inc. 21
Builders Providence, Division of B-I-F Industries, Inc . 5 and 136

Cast Iron Pipe Research Association . . . . . 26 and 27
Caterpillar Tractor Co. . . . . 12, 13 and 119
Chicago Bridge & Iron Co. 78
Columbia-Geneva Steel Division . . . . . 96 and 97
Concrete Reinforcing Steel Institute 73

Eugene Dietzgen Company 137
Douglas Fir Plywood Association 137

Earle Gear & Machine Company 133
Eastman Kodak Company 71
Edo Corporation 121
Electrovert, Ltd. 124

Filotecnica Salmoiraghi, Inc. 138
The Flexible Road Joint Machine Co. . . . . 24 and 25
Forney's Incorporated, Tester Division 21
L. B. Foster Company 1

General Electric Company 115
The Globe Company, Products Division 128
Granco Steel Products Co. 28
Graver Tank & Mfg. Co., Inc. 135

E. L. Hardin Associates, Inc. 104
Haven-Busch Company 127
Rodney Hunt Machine Co. 107

Ideal Cement Company 16
Imperial Tracing Cloth 121
International Harvester Co. . . . . 110 and 111
Intrusion Prepakt, Inc. 8
Irving Subway Grating Co., Inc. . . . . 2nd cover

Kern Instruments, Inc. 135
The Kinnear Manufacturing Co. 125
Klemp Metal Grating Corporation 102
W. J. Knox 132

The James Leffel & Co. 103
Lehigh Portland Cement Co. 87
Leupold & Stevens Instruments, Inc. 129
Link Belt Company 23
Lock Joint Pipe Company . . . . . 4th cover
Lone Star Cement Corporation 32

The Master Builders Company . . . . . 3rd cover
M & H Valve and Fittings Company 126
Moretrench Corporation 132

Naylor Pipe Company 77
Newport News Shipbuilding and Dry Dock Company . . . 89

Pennsylvania Drilling Co. 137
Pittsburgh-Des Moines Steel Co. 30
Portland Cement Association 106
Posey Iron Works, Inc. 18

Reynolds Metals Co. 91
John A. Roebling's Sons Corp. 101

Servicised Products Corp. 100
Sika Chemical Corp. 93
Soiltest, Inc. 138
S. Morgan Smith Co. 105
Sonoco Products Company 123
Spencer, White & Prentis, Inc. 122
John W. Stang Corporation 10
Superior Concrete Accessories, Inc. 79
Superior-Lidgerwood-Mundy Corp. 11
Sverdrup & Parcel, Inc. 118
Sverdrup & Parcel Engineering Co. 114

Tennessee Coal & Iron Division . . . . . 96 and 97
The Texas Company 108
Thompson Pipe & Steel Company 133
Tinney Drilling Co. 21

Union Metal Manufacturing Co. 15
United States Pipe and Foundry Co. . . . . 6 and 7
United States Steel Corporation . . . . . 9, 96 and 97
United States Steel Export Company . . . . . 9, 96 and 97
United States Steel Supply Company . . . . . 96 and 97
Universal Atlas Cement Co. 99
Universal Form Clamp Co. 95

Vulcan Iron Works, Inc. 136

Water Seals, Inc. 19
Wild Heerbrugg Instruments, Inc. 98
R.D. Wood Company . . . . . 130 and 131

Professional Services . . . . . 141, 142 and 143

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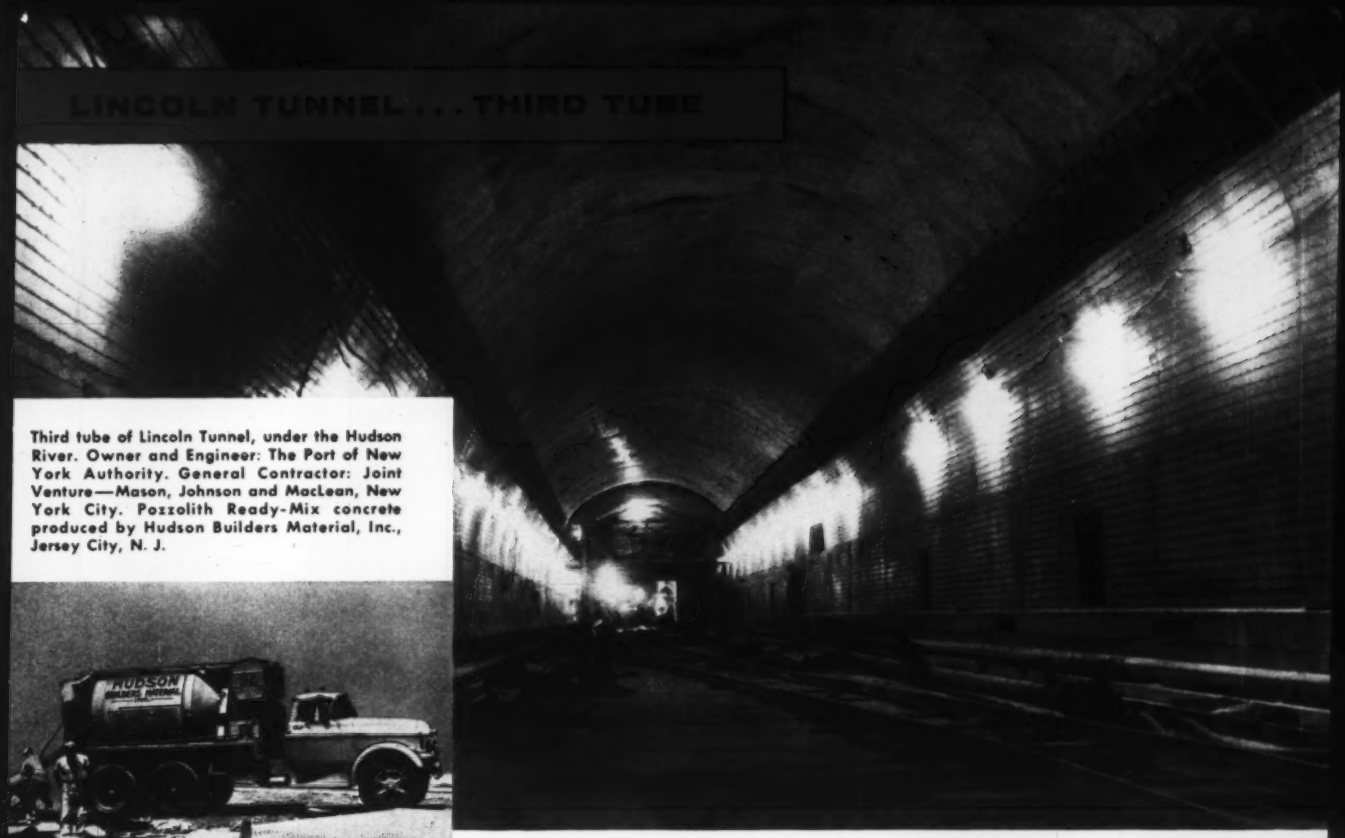

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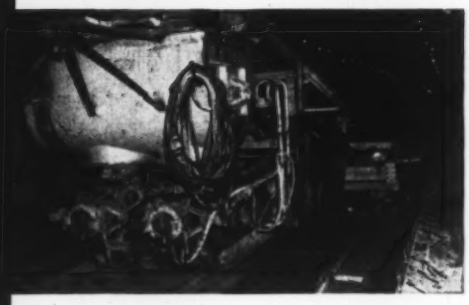

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